US006036636A

United States Patent [19]

Motoki et al.

[11] Patent Number: 6,036,636

[45] Date of Patent: Mar. 14, 2000

[54] ENDOSCOPE WITH TIP PORTION DISPOSED ON DISTAL SIDE OF INSERTION PORTION

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[21] Appl. No.: 08/968,579

[22] Filed: Nov. 13, 1997

[30] Foreign Application Priority Data

Nov. 18, 1996 [JP] Japan 8-306711
Jun. 4, 1997 [JP] Japan 9-146853

[51] Int. Cl.^{7} A61B 1/008

[52] U.S. Cl. 600/146; 600/151; 600/141

[58] Field of Search 600/141, 143, 600/146, 151, 127, 136; 604/95, 280

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4,198,960 4/1980 Utsugi 600/146
4,290,421 9/1981 Siegmund 600/146
4,790,624 12/1988 Van Hoye et al. .
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5,318,008 6/1994 Bullard 600/146
5,398,670 3/1995 Ortiz et al. 600/109
5,522,788 6/1996 Kuzmak .

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Primary Examiner—John P. Leubecker
Attorney, Agent, or Firm—Pillsbury Madison & Sutro LLP

[57] ABSTRACT

In an endoscope, an elastic member made of a super elastic alloy, for instance, bridges the distal end portion of an insertion portion and the proximal end portion of a tip portion so that a space portion having a given interval is formed in between. A curving mechanism advances or retreats a manipulation wire that extends from the tip portion to the proximal side of the insertion portion, whereby curving or bending occurs at the space portion between the tip portion and the insertion portion.

86 Claims, 23 Drawing Sheets

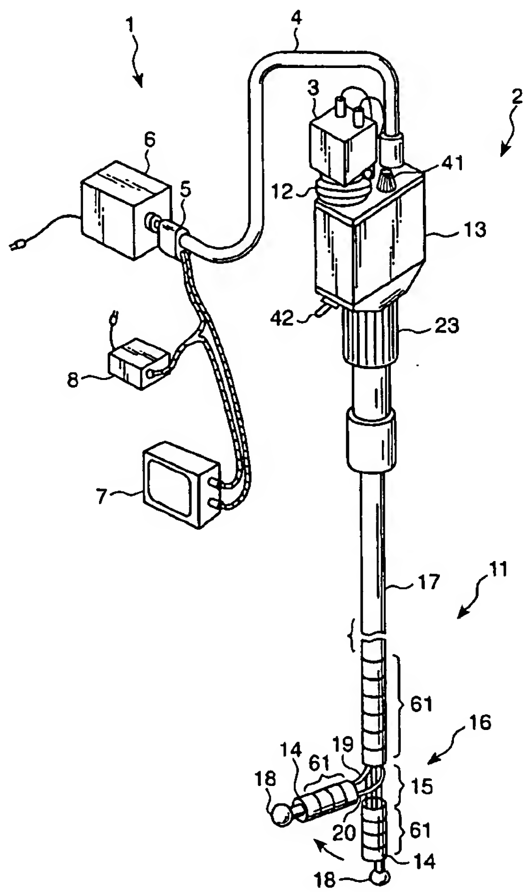
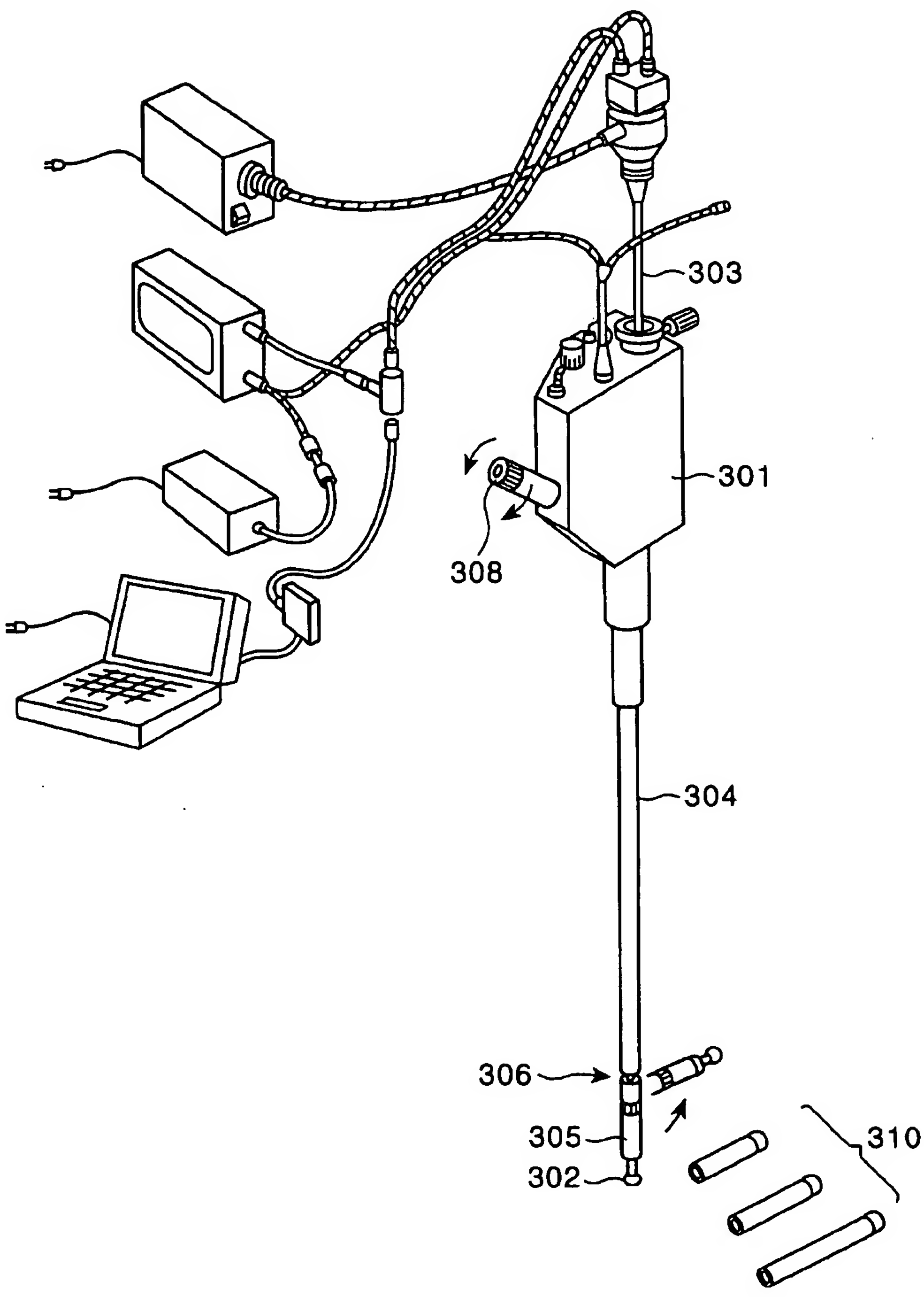


Fig. 1
(RELATED ART)



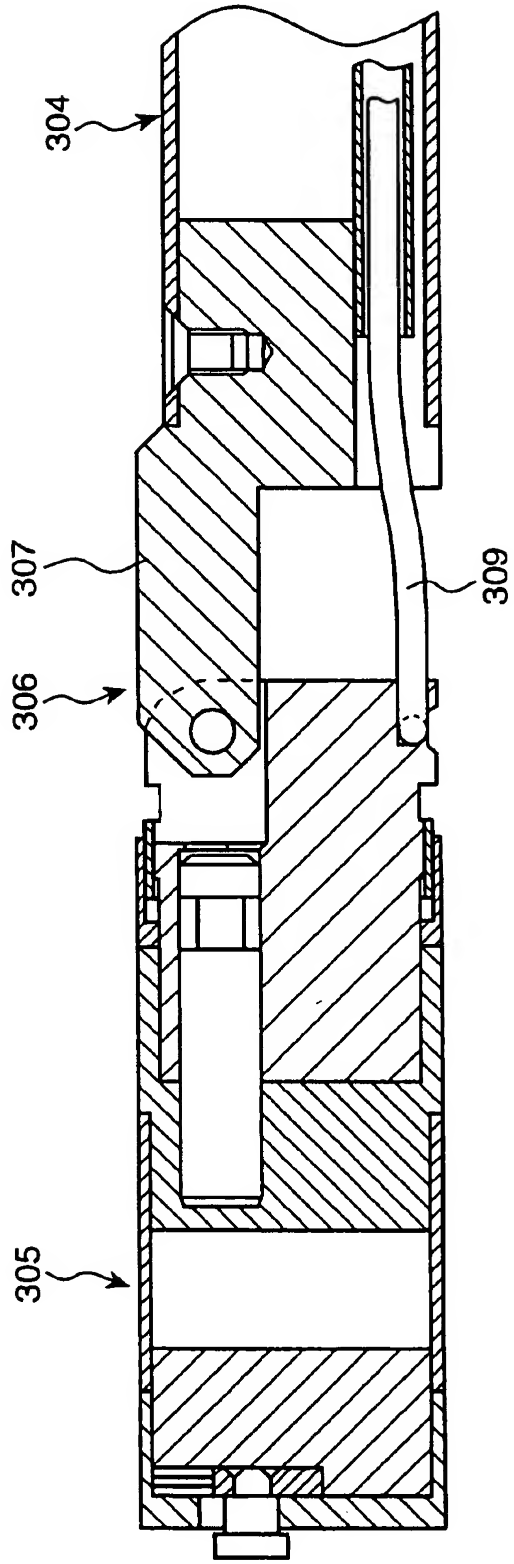


Fig. 2
(RELATED ART)

Fig. 3

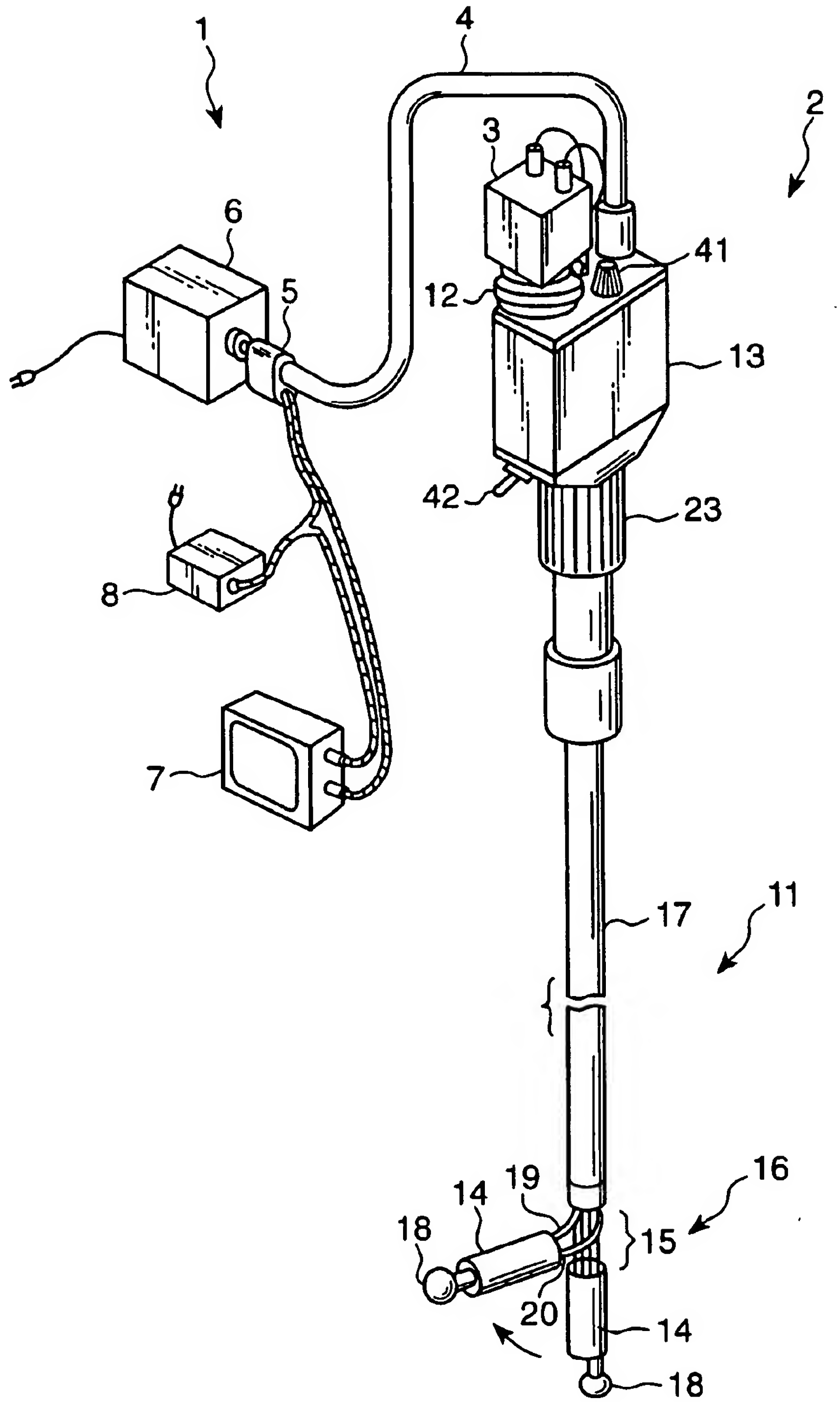


Fig. 4

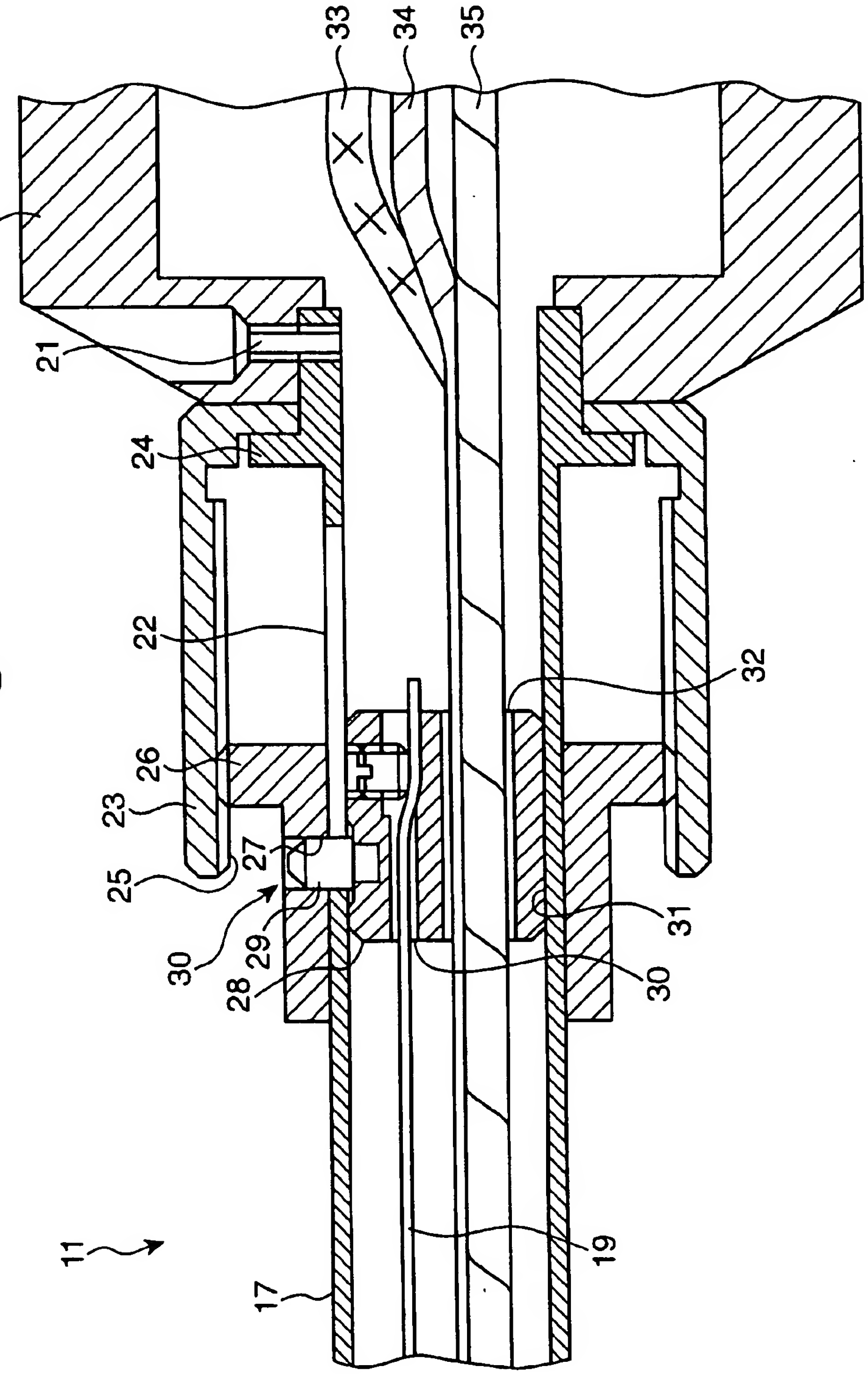


Fig. 5

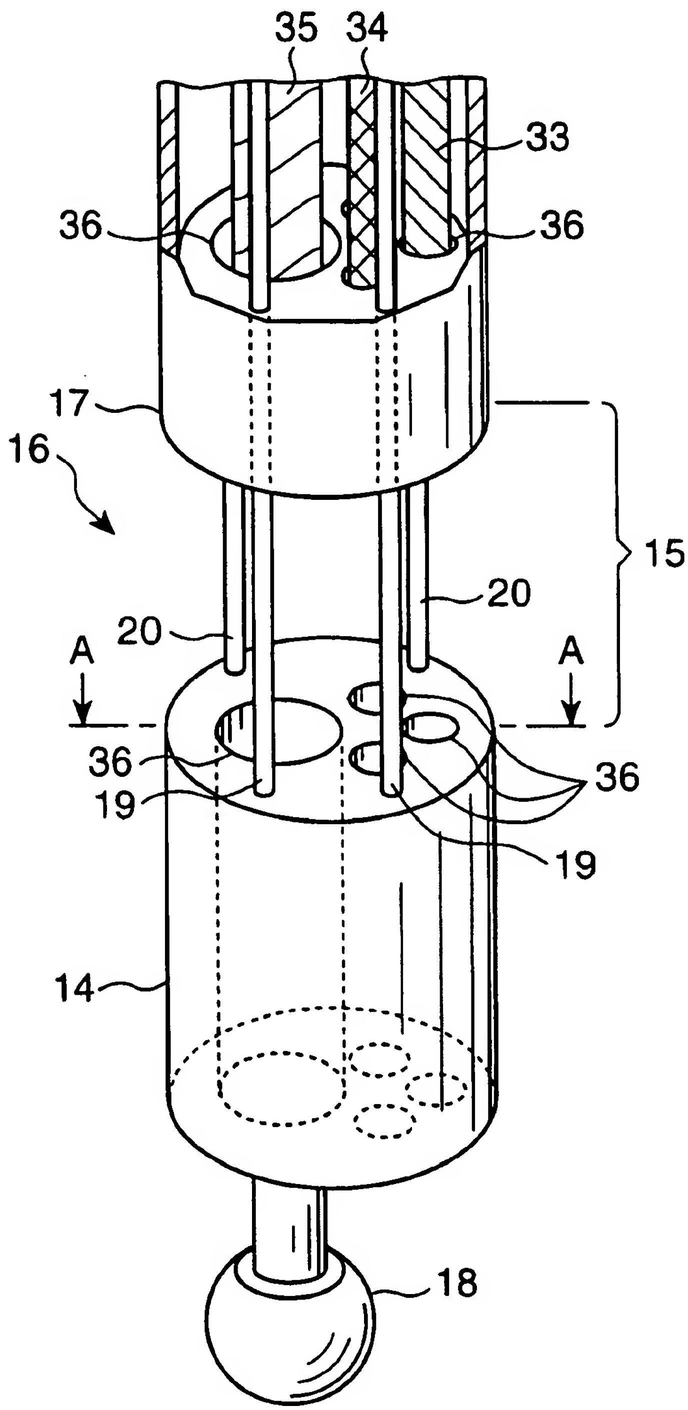


Fig. 6

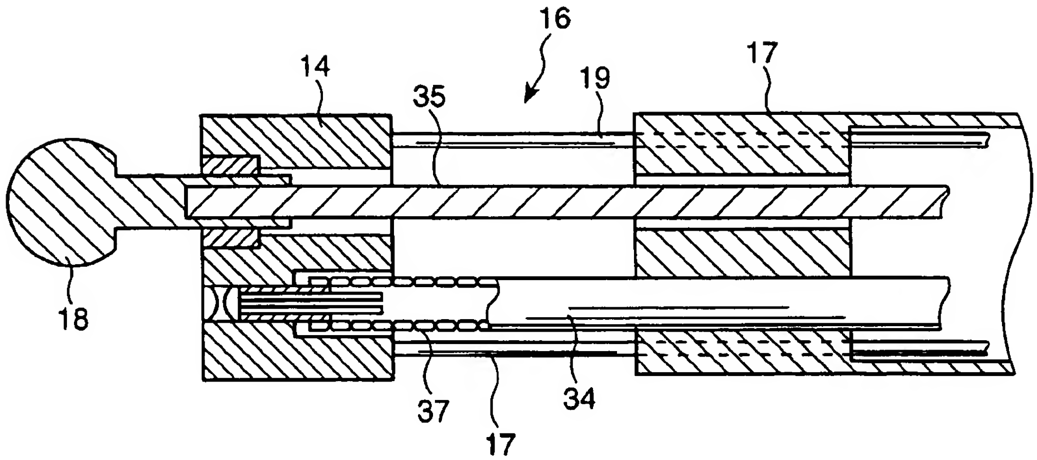


Fig. 7

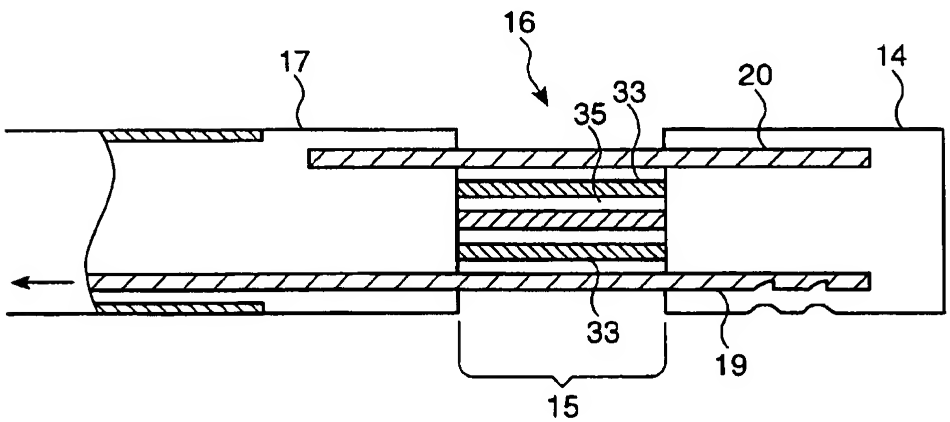


Fig. 8(a)

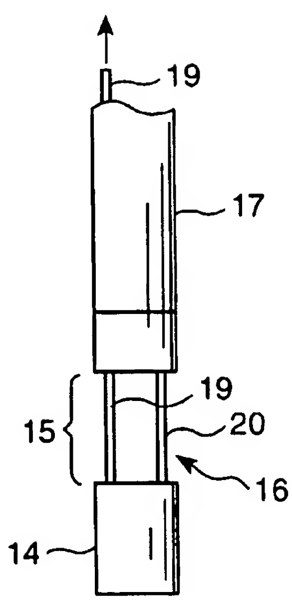


Fig. 8(b)

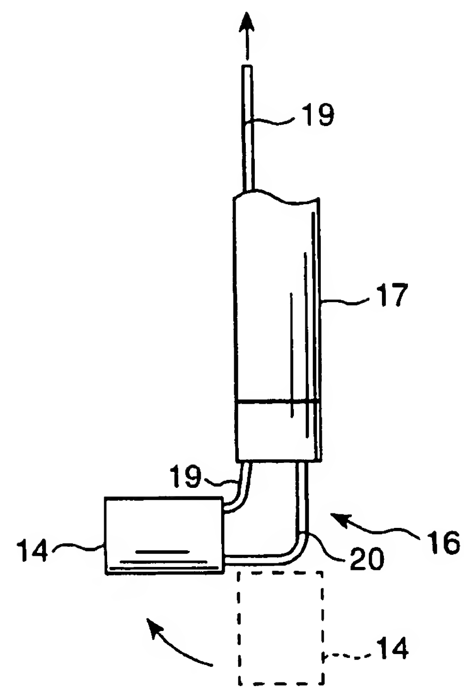


Fig. 9

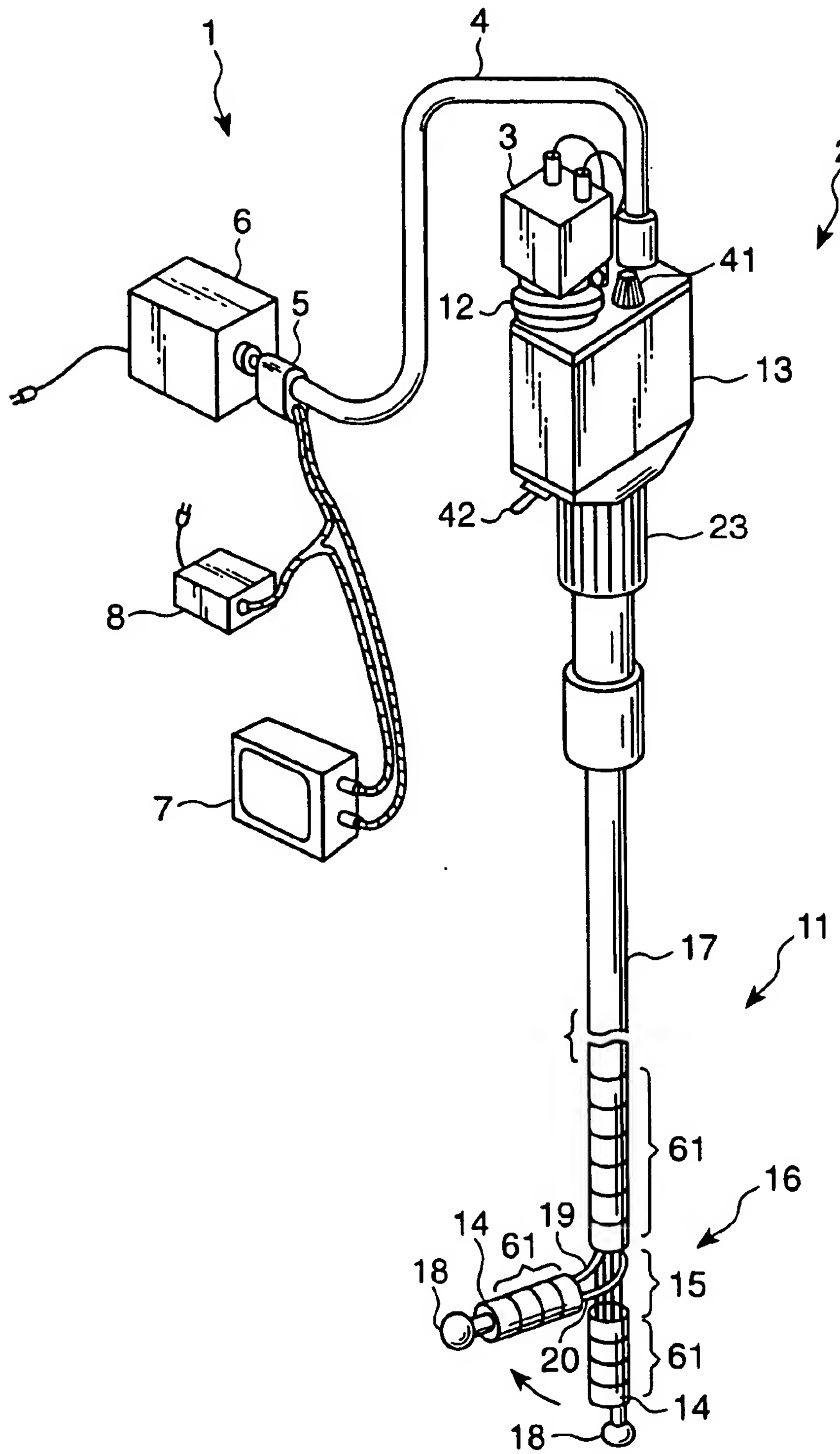


Fig. 10

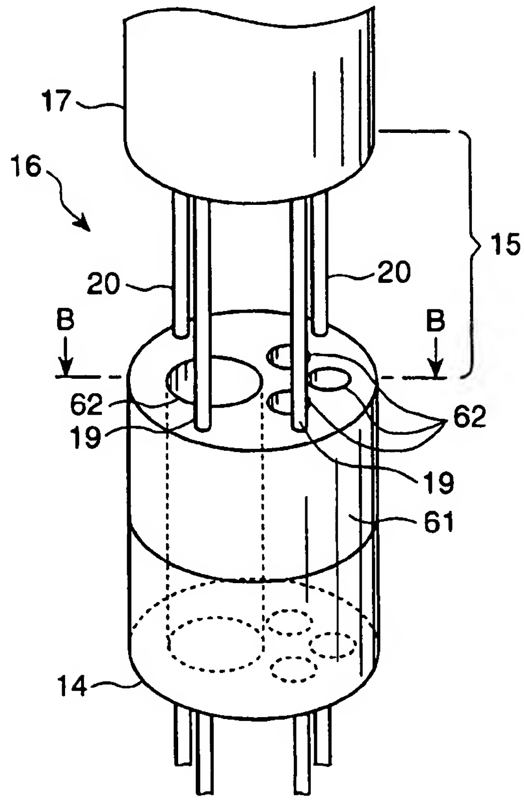


Fig. 11

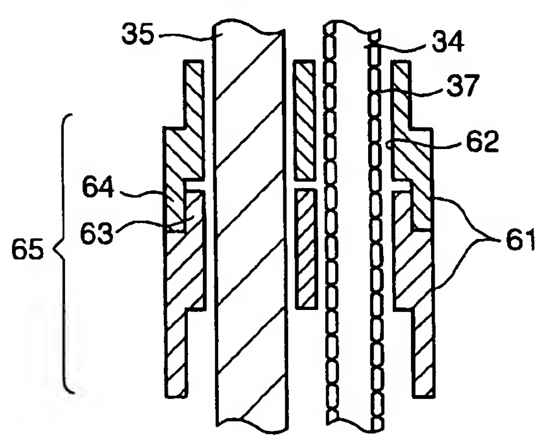


Fig. 12

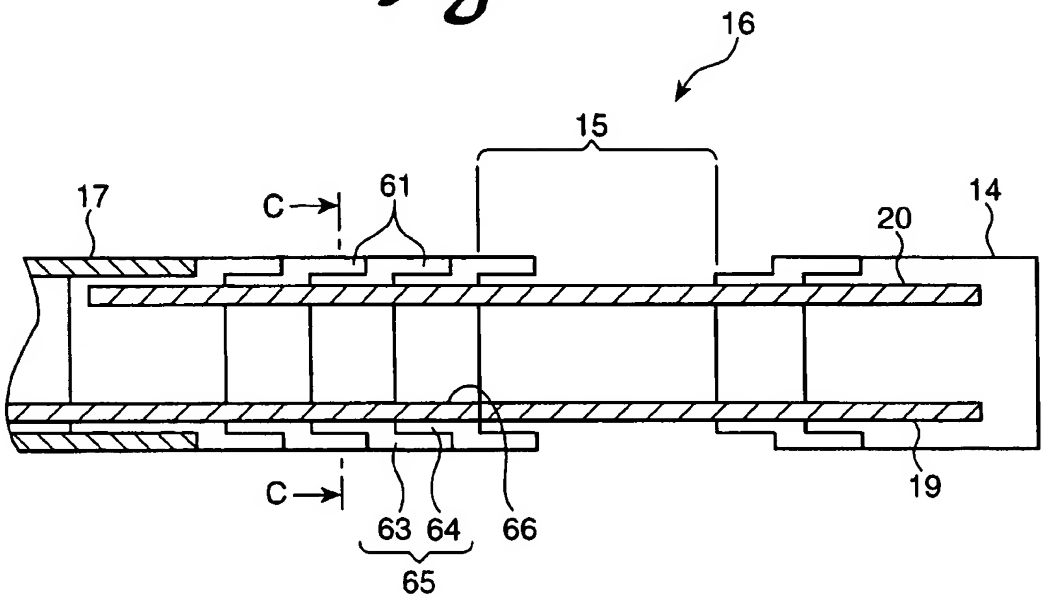


Fig. 13

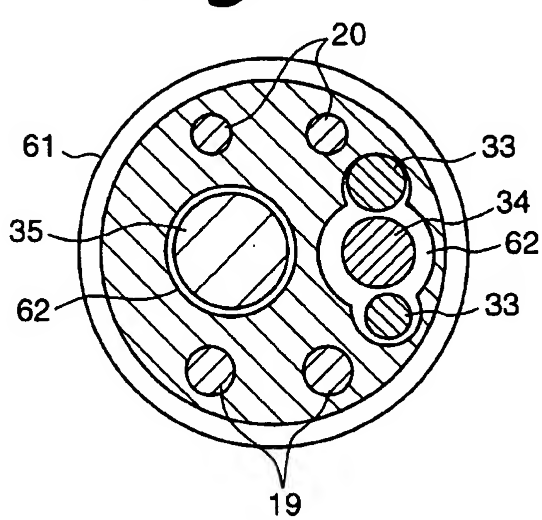


Fig. 14(a)

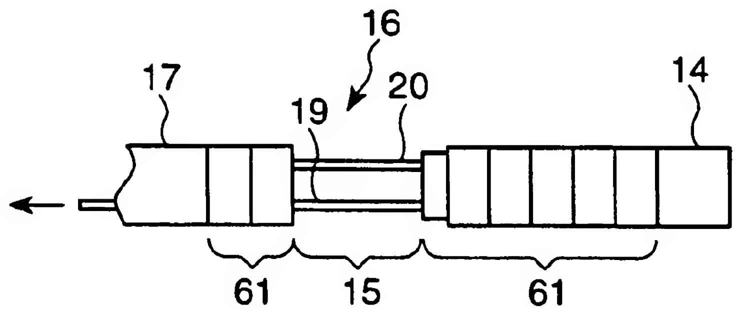


Fig. 14(b)

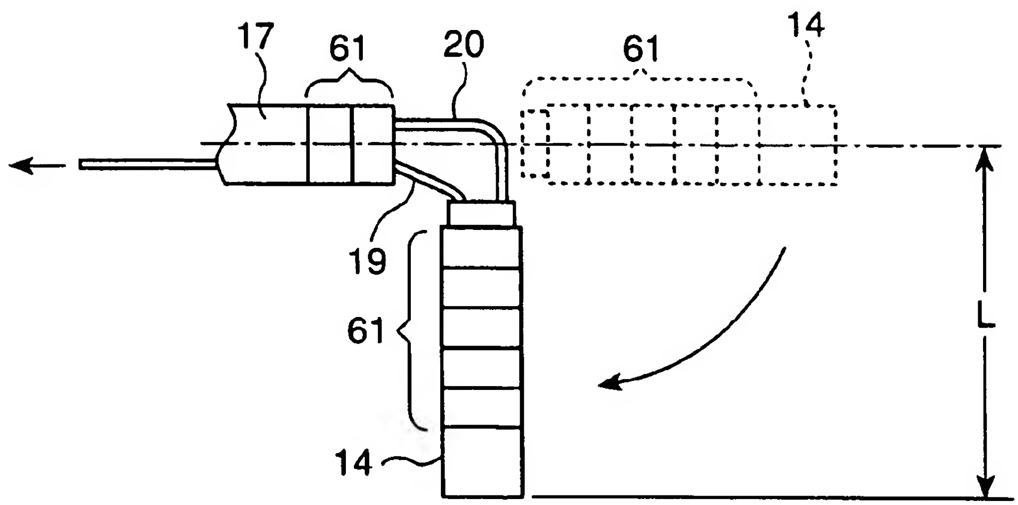


Fig. 15(a)

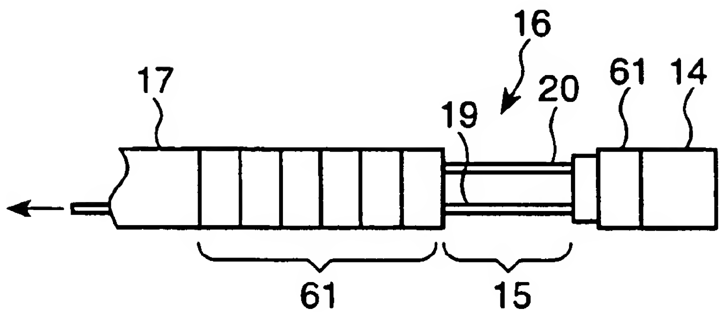


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Fig. 15(b)

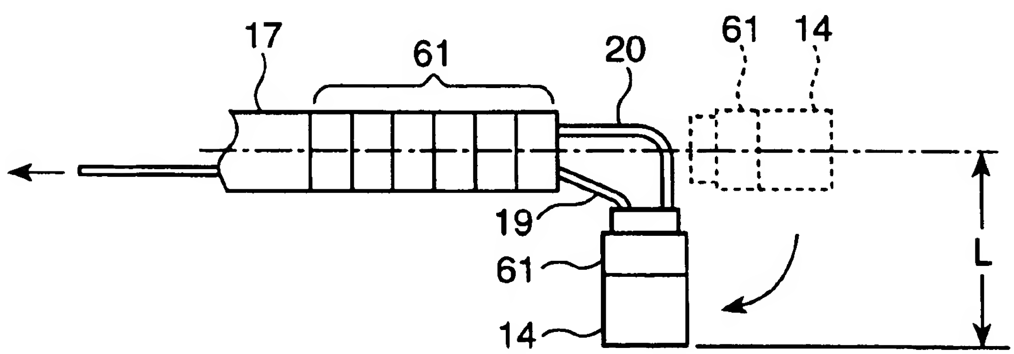
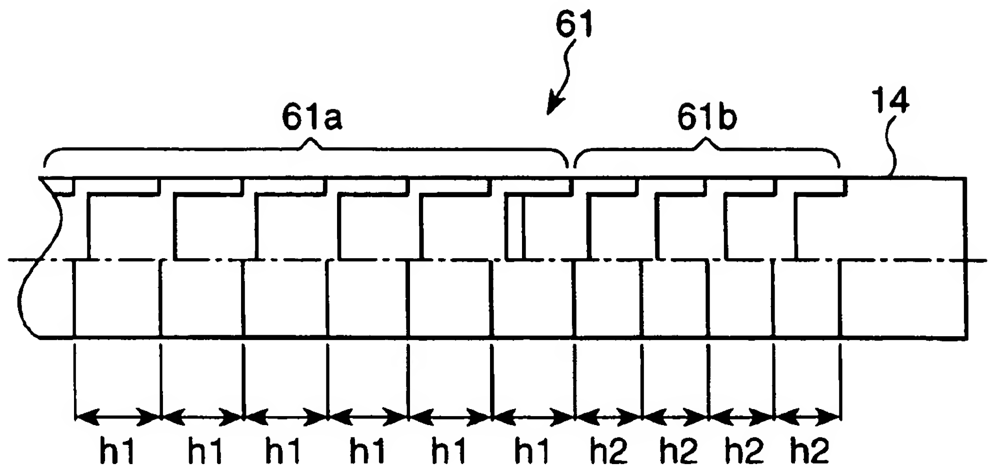


Fig. 16



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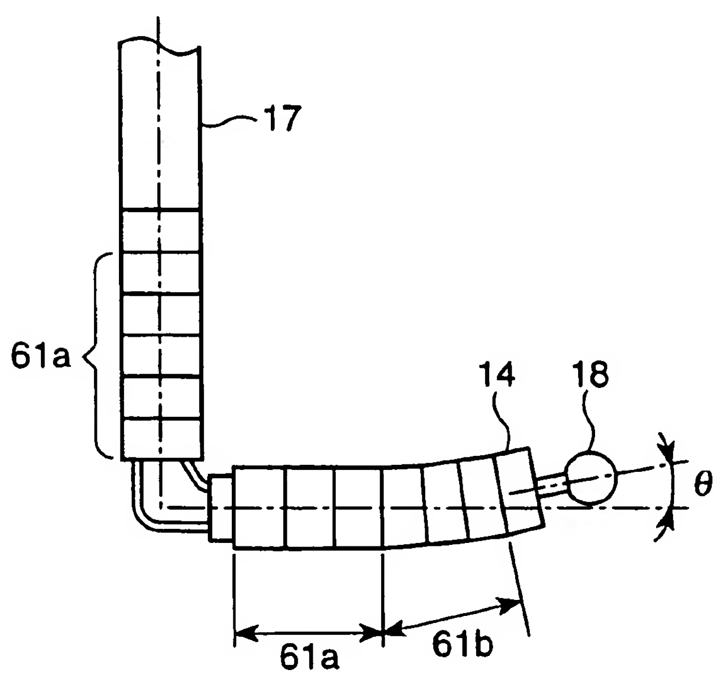

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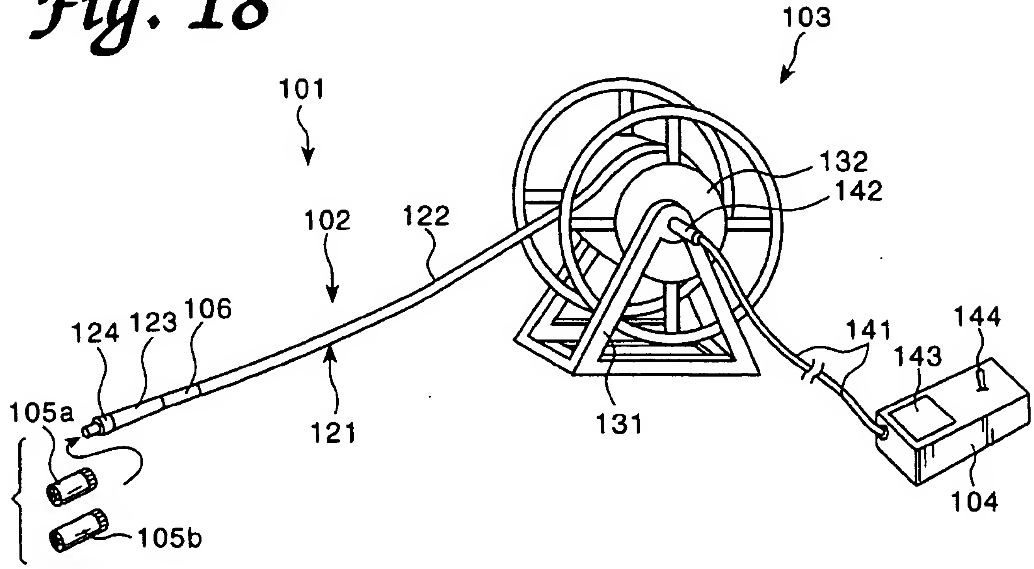


Fig. 19

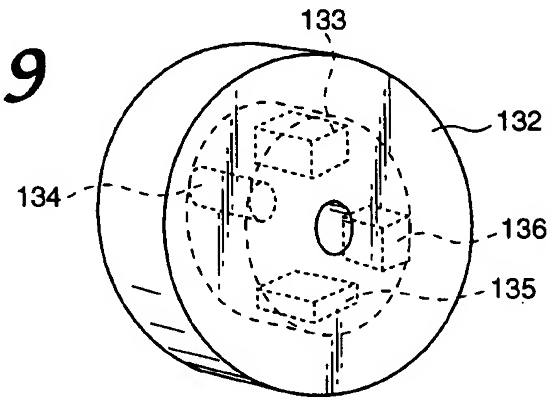
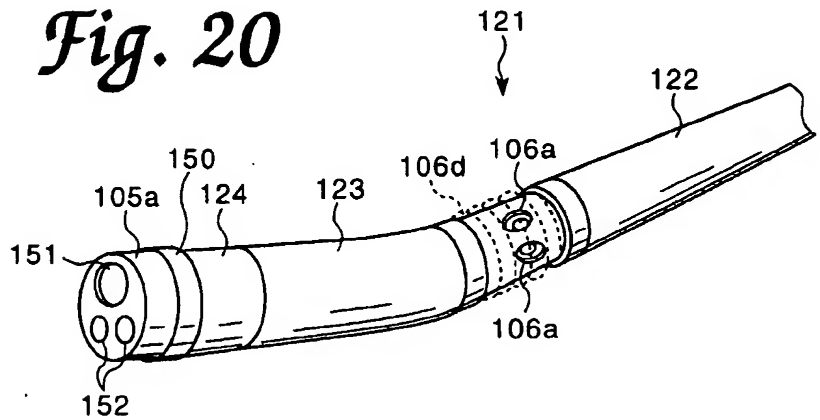


Fig. 20



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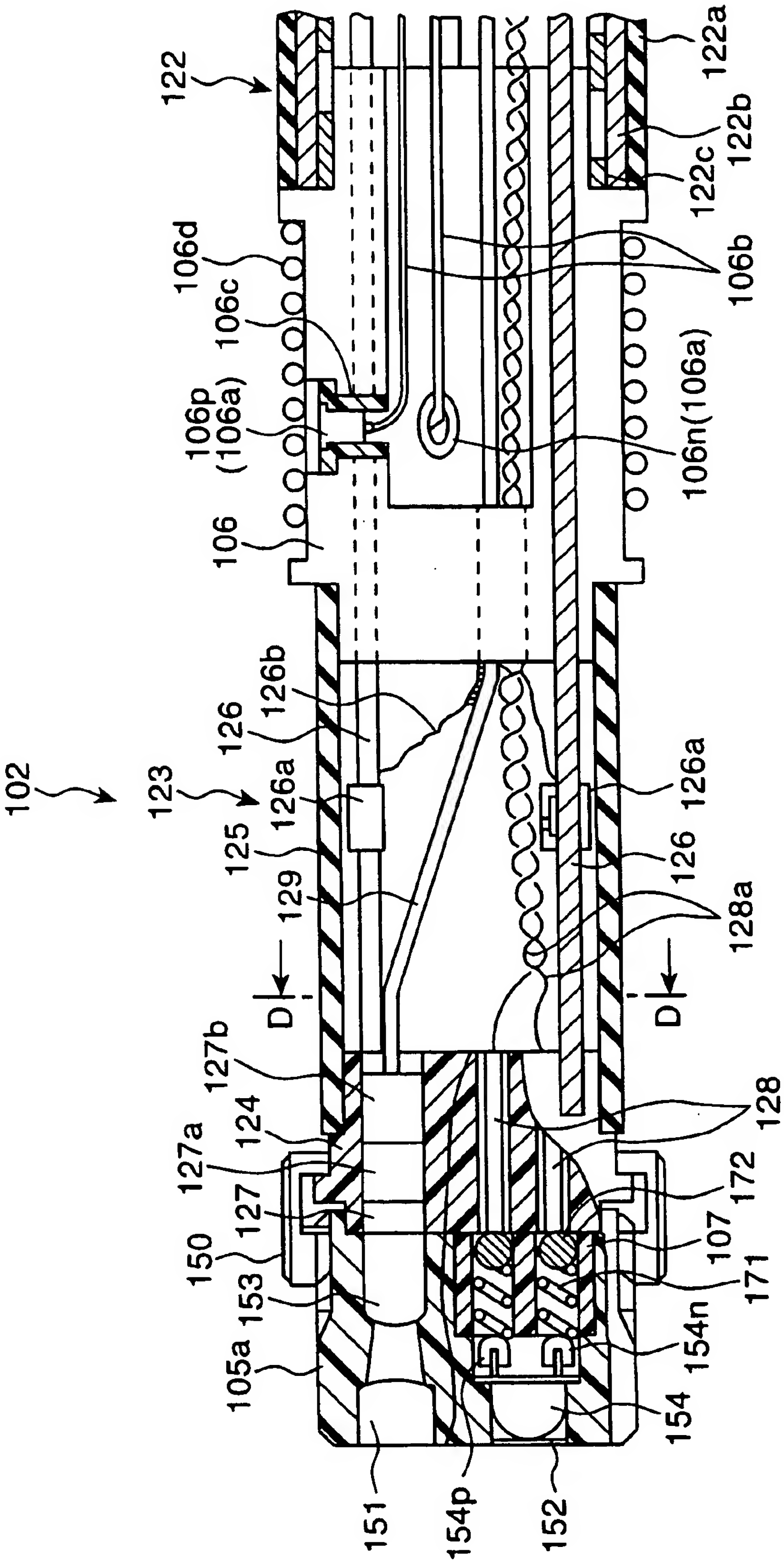
122
122a
122b
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106d
106c
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106p
(106a)
106n(106a)
106
102
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126a
125
129
128a
D
127b
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154n
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172
128

Fig. 22(a)

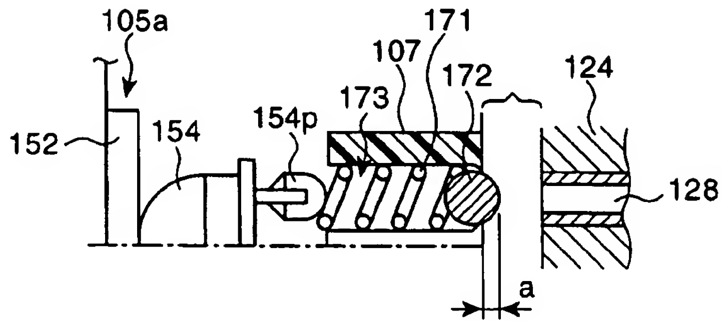


Fig. 22(b)

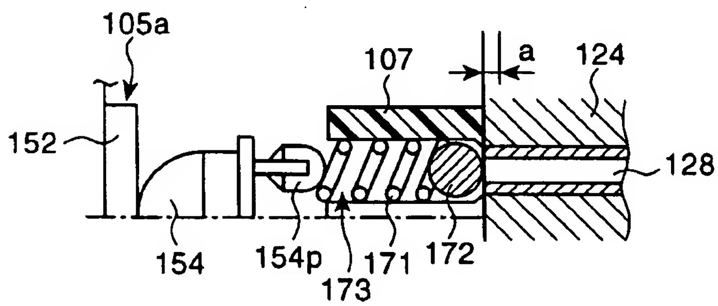
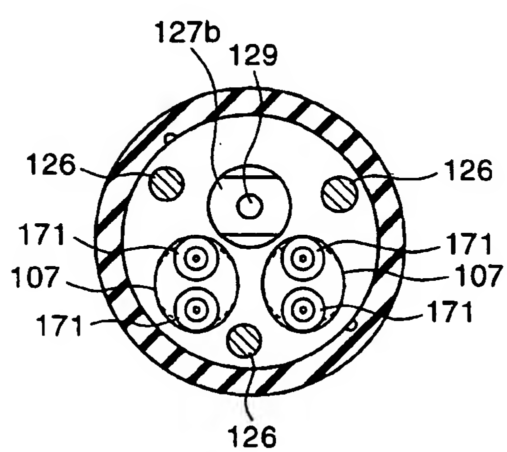
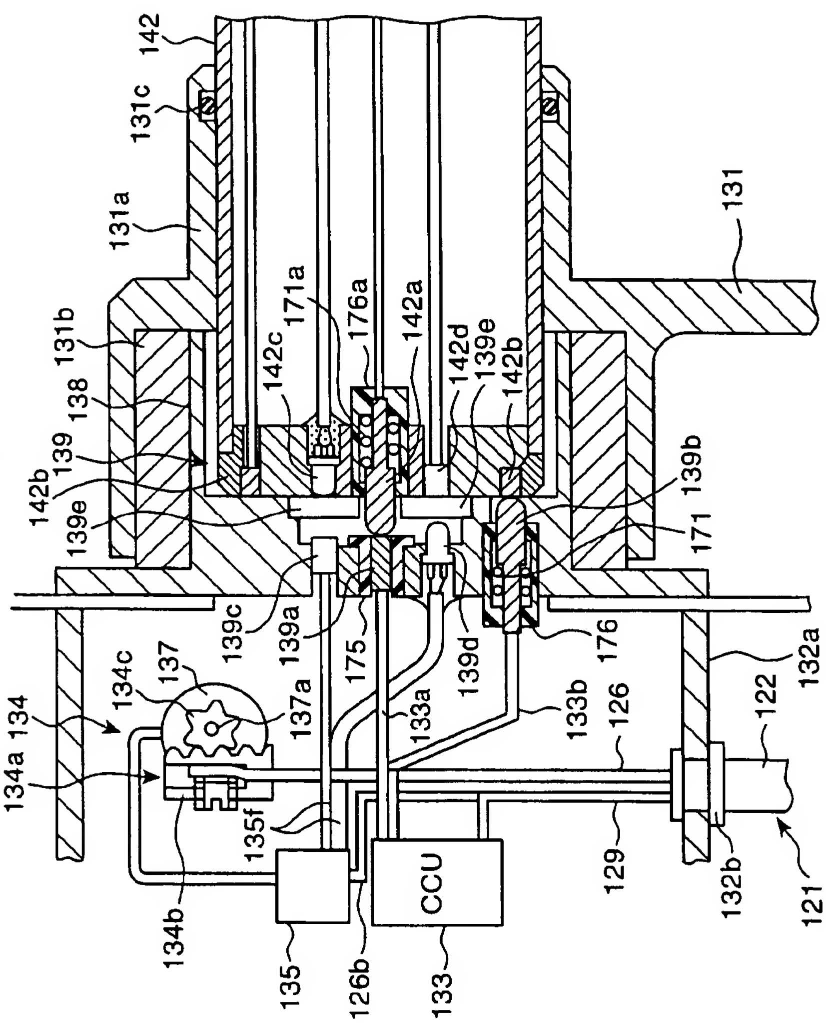


Fig. 23

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131b
138
139
142b
139e
171a
176a
142a
142c
142d
139e
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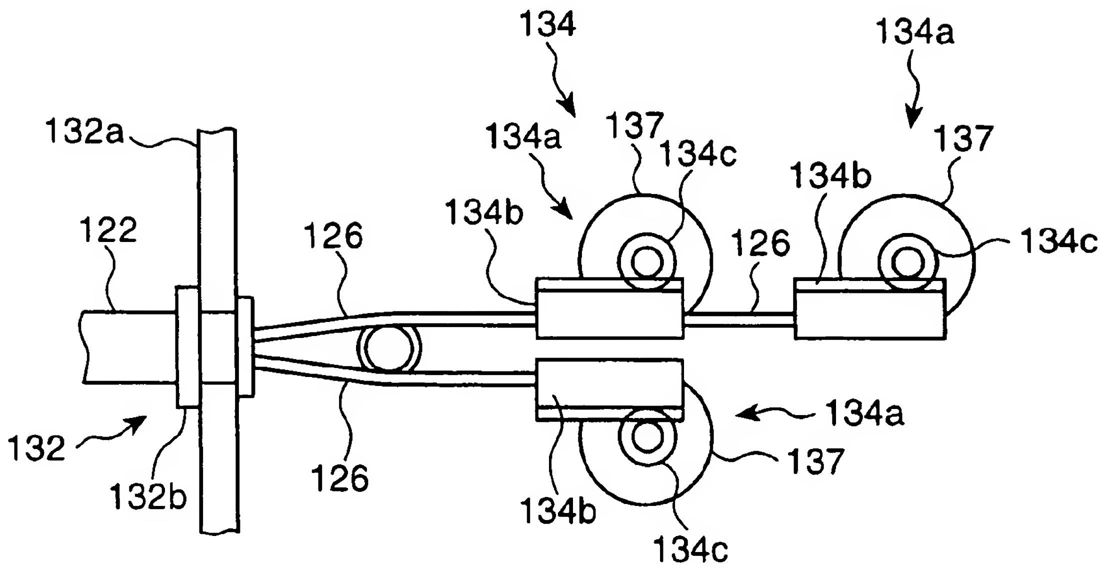
139b
171
139c
139a
175
139d
176
132
134a
134
134c
137
137a
133a
133b
126
122
132a
135f
134b
135
126b
CCU
133
129
132b
121

Fig. 24

Fig. 25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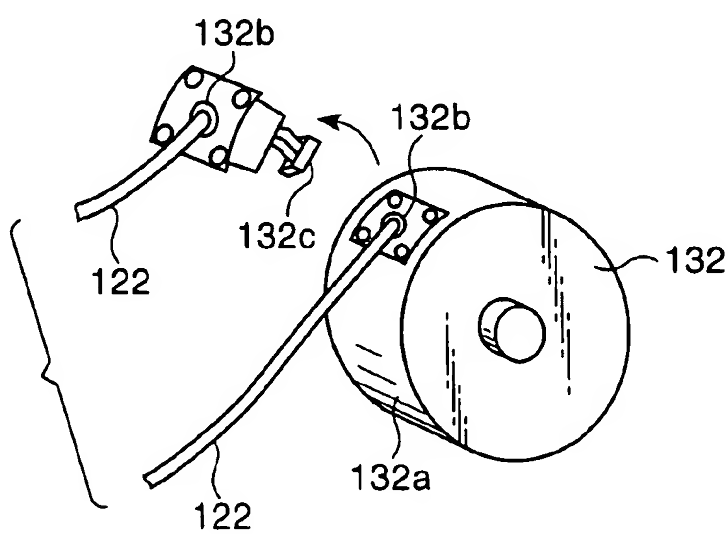
134b
137
134c

Fig. 26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132b
132c
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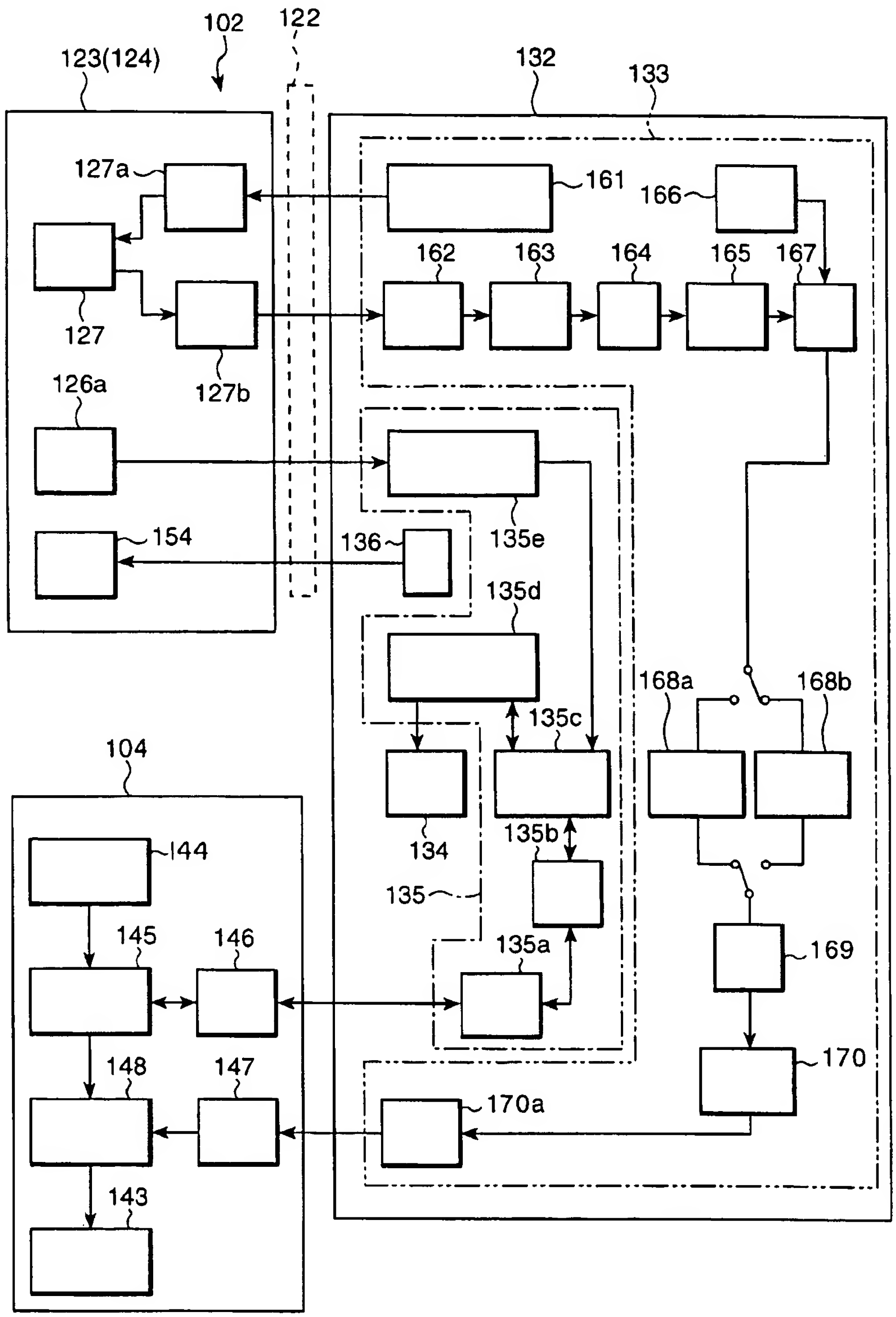
132
132a
122

Fig. 27



102
122
123(124)
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127a
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162
163
164
165
167
127
127b
126a
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154
136
135d
168a
168b
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135a
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148
147
170
170a
143

Fig. 28

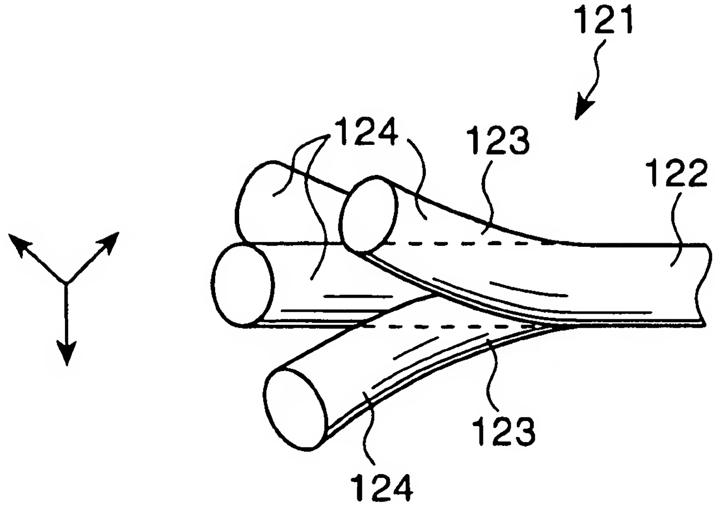
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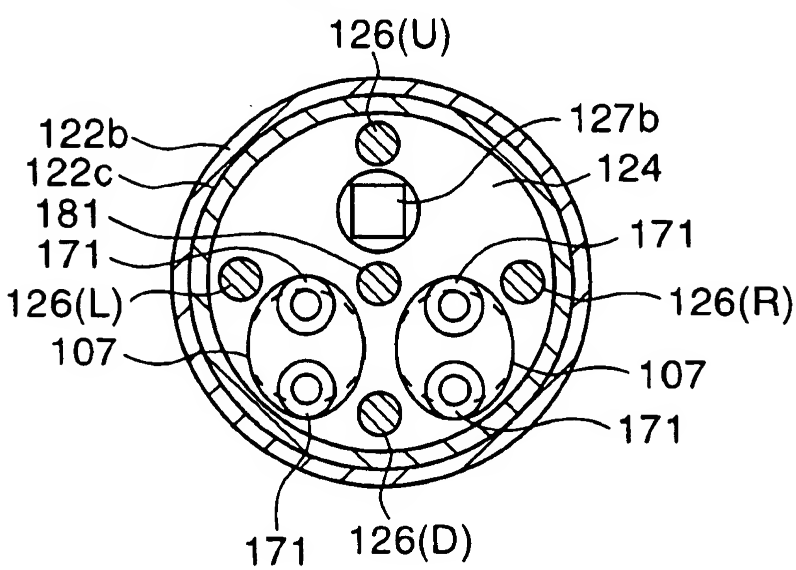
Fig. 29


126(U)
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171
126(L)
126(R)
107
107
171
171
126(D)

Fig. 30

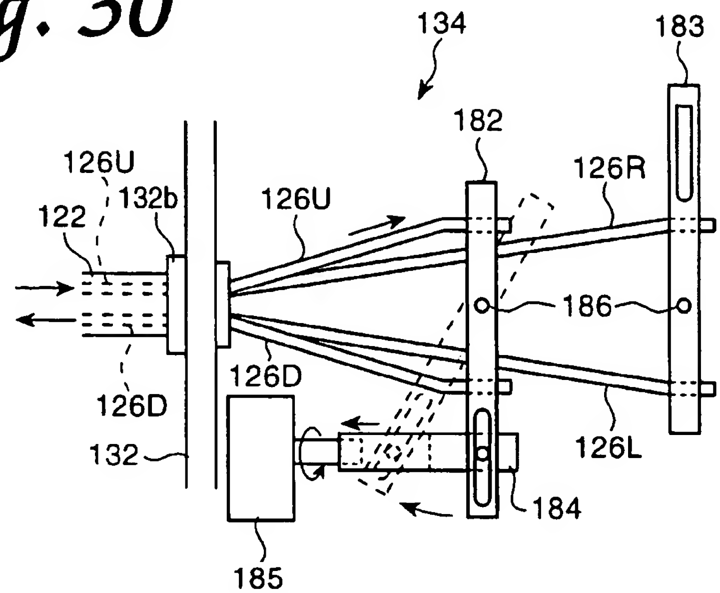


Fig. 31

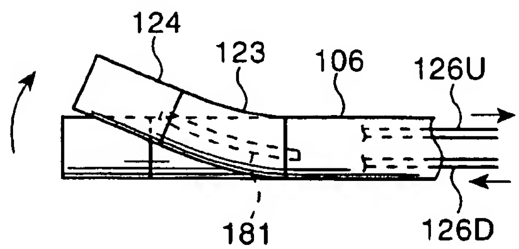


Fig. 32

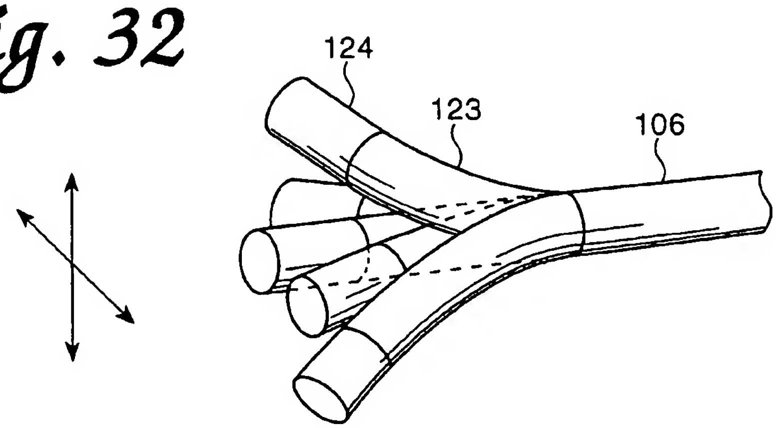


Fig. 33

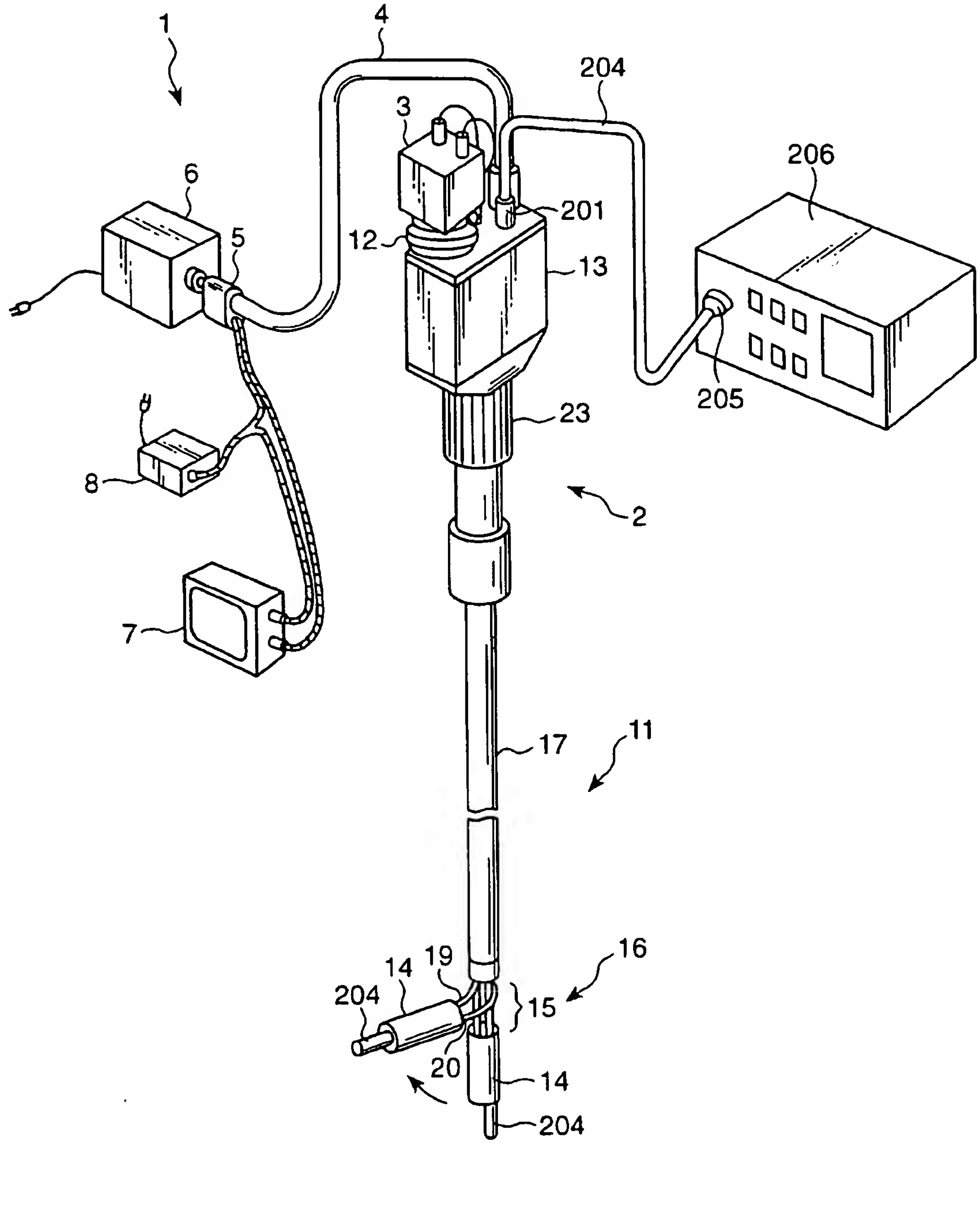
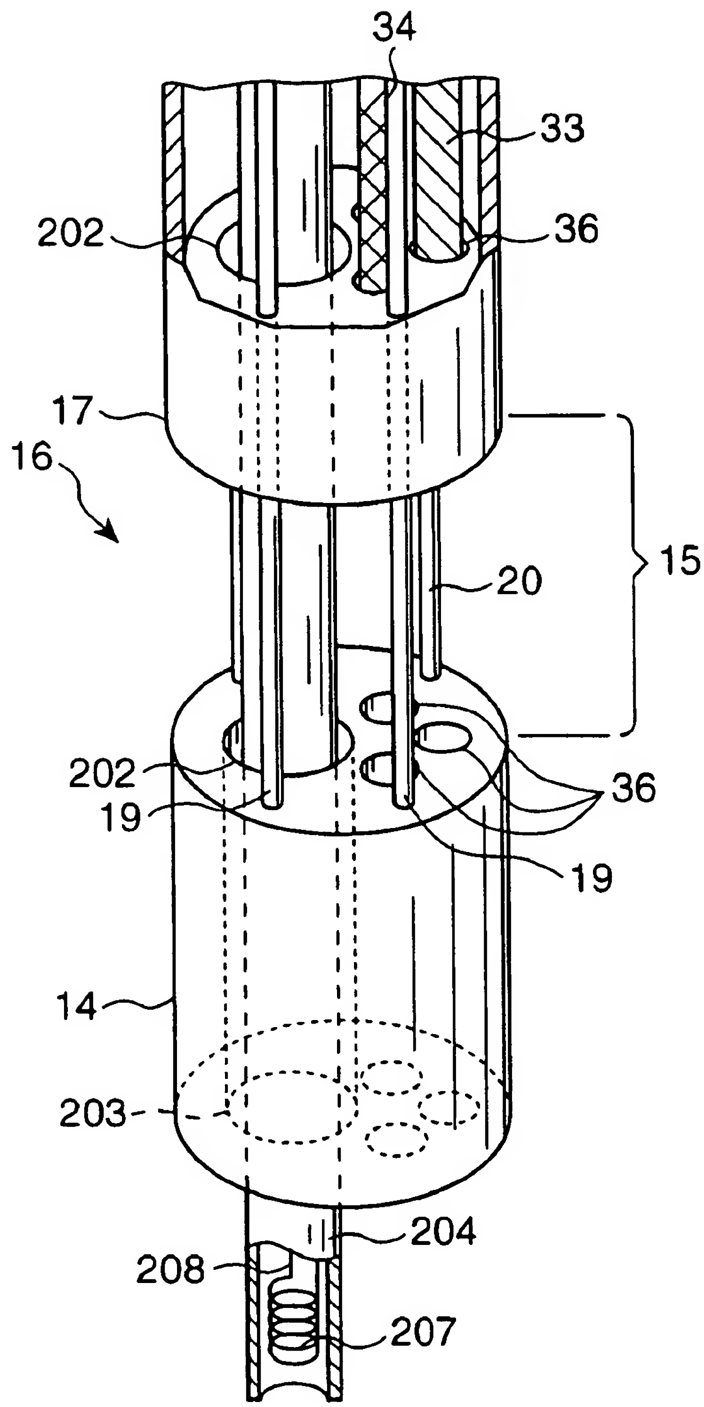


Fig. 34



ENDOSCOPE WITH TIP PORTION DISPOSED ON DISTAL SIDE OF INSERTION PORTION

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to an endoscope and, more specifically, to an endoscope featured by a curving mechanism for curving a curving portion.

2. Description of the Related Art

In a non-destructive inspection of compressor blades (hereinafter referred to as "blades") inside a jet engine by means of an industrial endoscope, there may be found damage such as a nick or a crack in a blade edge as caused by sucking of a bird, a stone, a piece of ice, or the like during operation of the jet engine.

In such a case, even if a damaged portion is small, if the jet engine is used without repairing it, stress may be concentrated on the damaged portion, possibly enlarging the damaged portion. When a damaged blade becomes not suitable for use, a common procedure is to disassemble and repair the jet engine. The damaged blade is removed from the engine, and is repaired by grinding into such a shape that there occurs no stress concentration on the damaged portion or replaced by a new one. However, the procedure of disassembling an engine and performing a grinding operation every time a small damaged portion is found has a problem that the repairing takes undue cost and time.

In general, a jet engine has, approximately for each blade, a hole (hereinafter referred to as "access port") for inspection of the blade. Various industrial endoscope apparatuses have been proposed that can repair, by grinding, a damaged portion of a blade edge to avoid stress concentration during operation without disassembling the engine such that a processing device mounted with a rotary processing member at its tip is inserted, together with an industrial endoscope, into the inside of the engine through the access port, then the rotary processing member located at the tip is opposed to the blade by bending the tip portion of the processing device, and finally the rotary processing member is rotated.

There is a certain distance between each access port and the corresponding blade, and the distance depends on the location in an engine and the type of engine. Further, after the processing device is inserted into the engine, the rotary processing member needs to be brought into contact with the blade by curving the tip portion of the endoscope apparatus.

Conventionally, as disclosed in, for instance, U.S. Pat. Nos. 5,251,611 and 5,522,788, the curving structure of ordinary endoscopes is used in which to obtain a curve a curving portion is formed by connecting together a plurality of block members. However, in this case, because of a gap between the opposed faces of the curving blocks of the curving portion, the portion on the tip side of the curving portion easily wobbles due to reaction force of grinding, disabling stable operation. Further, since the curving portion has a certain curvature, the accessibility is poor when a blade close to the access port is to be ground. U.S. Pat. No. 5,522,788 has an additional problem that the length of the portion on the tip side of the curving location cannot be changed freely as occasion demands.

U.S. Pat. No. 4,790,624 proposes a prior art technique having a curving structure that can be curved at a very small radius of curvature. This is configured such that a bending portion having a given space is formed between a tip member and an insertion member and a bending member consisting of a plurality of shape-memory alloy elements is provided in the bending portion. Bending is effected by controlling the heating of the shape-memory alloy elements of the bending member.

However, U.S. Pat. No. 4,790,624 has problems that to obtain a curve it is necessary to continue heating the shape-memory alloy elements, and that a fine temperature control for the curve control is difficult.

In view of the above, the present assignee filed Japanese Patent Application No. Hei. 8-109586. FIGS. **1** and **2** show this apparatus.

This apparatus comprises a processing device main body **301**, a rotary processing member **302** and an endoscope **303**. The processing main body **301** is composed of an insertion portion **304** and a tip member **302**. A bending portion **306** is formed between the insertion portion **304** and the tip member **305** so as to provide a given space in between. As shown in FIG. **2**, having a hinge structure, the bending portion **306** is bent by means of a manipulation wire **309** that is pulled as a rotation adjustment knob **308** is rotated. The processing device main body **301** guides the rotary processing member **302** and the endoscope **303** to the tip member **305**. To accommodate the fact that the distance between an access port and a blade varies case by case, adaptors **310** having a plurality of lengths are provided for the tip member **305** to change the distance between the bending portion **306** and the rotary processing means **302**.

However, since the bending portion **306** has the hinge structure, the above configuration has a problem that the bending portion **306** does not have a sufficient spatial margin for accommodation of such internal components as the rotary processing device **302** and the endoscope **303**. To secure a sufficient spatial margin, the diameter of the insertion portion **304** including the bending portion **306** necessarily increases. On the other hand, to decrease the diameter, because of the insufficient spatial margin, it is necessary to thin a rotary shaft for rotating the rotary processing member **302** or an image guide and a light guide in the endoscope **303**. If the image guide is thinned, there occurs a problem that an image having a sufficient number of pixels cannot be obtained. If the light guide is thinned, there arises a problem that illumination of sufficient brightness cannot be obtained. If the rotary shaft is thinned, there occurs a problem of insufficient strength.

The adaptors **310** are attached and removed to change the distance between the bending portion **306** and the rotary processing member **302**. However, this is associated with problems that the operation of attachment and detachment of the adaptors **310** is complex and that the preparation of a plurality of replacement adaptors **310** having different lengths is costly.

SUMMARY OF THE INVENTION

The present invention has been made in the above circumstances, and an object of the invention is to provide an endoscope having a curving portion or a bending portion that secures sufficient space for internal components and can maintain a curve angle in a stable manner.

Specifically, an object of the invention is to provide an endoscope in which the portion on the tip side of the curving or bending portion does not wobble.

Another object of the invention is to provide an endoscope which allows the position of the curving or bending portion to be adjusted easily when occasion demands.

Another object of the invention is to provide an endoscope which secures a space for accommodating components incorporated in the curving or bending portion.

Another object of the invention is to provide an endoscope in which a manipulation relating to a curving or bending control can be made easily.

A further object of the invention is to provide an endoscope having a curving portion that can be curved to an arbitrary direction.

A still further object of the invention is to provide an endoscope having an eddy current examination probe for non-destructive inspection of damage in mechanical members.

The invention provides an endoscope comprising an elongate insertion portion; a tip portion disposed on a distal side of the insertion portion; an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval; a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion; and a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire.

In the endoscope of the invention, the space portion is formed by the elastic member between the distal end portion of the insertion portion and the proximal end portion of the tip portion, and the space portion can be curved or bent by advancing or retreating the manipulation wire by the curving mechanism. Therefore, the curving portion can be obtained which secure sufficient space for internal components and can maintain a curve angle in a stable manner.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the configuration of an industrial endoscope apparatus previously filed by the present assignee;

FIG. 2 is a sectional view showing a bending structure of a processing device main body shown in FIG. 1;

FIG. 3 shows the configuration of an industrial endoscope apparatus according to a first embodiment of the invention;

FIG. 4 is a sectional view showing a structure of a tip-side portion of a manipulation portion and a proximal end portion of an insertion tube that are shown in FIG. 3;

FIG. 5 shows a structure of a tip portion and a curving portion that are shown in FIG. 3;

FIG. 6 is a sectional view taken along line A—A in FIG. 5;

FIG. 7 illustrates how first and second wire members are fixed in the curving portion shown in FIG. 3;

FIGS. 8(*a*) and 8(*b*) illustrate action of the curving portion that is caused by the first and second wire members shown in FIG. 3;

FIG. 9 shows the configuration of an industrial endoscope processing apparatus according to a second embodiment of the invention;

FIG. 10 shows a structure of a tip portion and a curving portion shown in FIG. 9;

FIG. 11 is a sectional view taken along line B—B in FIG. 10;

FIG. 12 illustrates the shape of blocks that constitute the curving portion shown in FIG. 9;

FIG. 13 is a sectional view taken along line C—C in FIG. 12;

FIGS. 14(*a*)–14(*b*) and 15(*a*)–15(*b*) illustrate action of the curving portion that is attained by the blocks shown in FIG. 12;

FIG. 16 shows a modification of the second embodiment and illustrates shapes of blocks that are modified from the blocks shown in FIG. 12;

FIG. 17 illustrates action of the curving portion that is attained by the blocks shown in FIG. 16;

FIG. 18 illustrates a general configuration of an endoscope apparatus according to a third embodiment of the invention;

FIG. 19 illustrates a general configuration of a drum portion shown in FIG. 18;

FIG. 20 is a perspective view showing the tip-side portion of an insertion portion shown in FIG. 18;

FIG. 21 is a sectional view showing a tip-side structure of the insertion portion shown in FIG. 18;

FIGS. 22(*a*) and 22(*b*) illustrate the structure and operation of a conduction holder that is provided in a tip adaptor shown in FIG. 21;

FIG. 23 is a sectional view taken along line D—D in FIG. 21;

FIG. 24 illustrates a connection relationship between the drum portion shown in FIG. 18 and connectors and a structure of an actuator section that is provided in the drum portion;

FIG. 25 illustrates a specific structure of the actuator section shown in FIG. 24;

FIG. 26 illustrates a specific example of a manner of attaching the inserting portion to the drum portion, both shown in FIG. 18;

FIG. 27 is a block diagram showing a general configuration of the endoscope apparatus of FIG. 18;

FIG. 28 illustrates a curving state of the curving portion shown in FIG. 18;

FIG. 29 is a sectional view of a curving portion of an endoscope having four manipulation wires and one interval maintaining wire according to a fourth embodiment of the invention;

FIG. 30 illustrates a structure of a link mechanism that constitutes an actuator section of the endoscope of FIG. 29;

FIG. 31 illustrates action of the link mechanism of FIG. 30;

FIG. 32 illustrates a curving state of the curving portion in the fourth embodiment;

FIG. 33 shows the configuration of an industrial endoscope processing apparatus according to a fifth embodiment of the invention; and

FIG. 34 shows a structure of a tip portion and a curving portion shown in FIG. 33.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

FIGS. 3–8 relate to a first embodiment of the present invention.

As shown in FIG. 3, an industrial endoscope processing apparatus 1 according to the first embodiment consists of the following components. When inserted in the inside of a jet engine, for instance, an industrial endoscope 2 enables observation of a body to be ground and grinds it. A CCD camera 3 is threadedly connected to a proximal end portion of the industrial endoscope 2. A light source device 6 is connected to a light source connector 5 that is provided at the tip of an universal cable 4 extending from a proximal end portion of the industrial endoscope 2. A LCD monitor 7 for displaying an image of a body to be ground is electrically

connected to the CCD camera 3 via the universal cable 4. A power supply 8 is electrically connected to the industrial endoscope 2, the CCD camera 3, and the LCD monitor 7 and supplies power to those devices.

The industrial endoscope 2 comprises an elongate insertion portion 11 and a box-shaped manipulation portion 13 having a mount portion 12 and provided on the proximal end side of the insertion portion 11. The universal cable 4 extends from the mount portion 12, and the CCD camera 3 is detachably connected to the mount portion 12. The insertion portion 11 includes, in order from the tip, a tip portion 14, a curving portion 16 having a plurality of wire members (described later) and a predetermined interval 15, and a rigid, an elongate insertion tube 17. A grindstone 18 that is provided at a rotational force transmission member (described later) and serves to grind a subject body projects from the tip portion 14.

The plurality of wire members of the curving portion 16 consist of two first wire members 19 and two second wire members 20. The first and second wire members 19 and 20 are metal wire members that are high in both straight extendability and flexibility, such as made of a super elastic alloy that is a Ni—Ti alloy.

Although in this embodiment the first wire members 19 and the second wire members 20 are each a set of two wire members, they may each be a single wire rod or a set of three or more wire members.

As described later, the first wire members 19 and the second wire members 20 are provided so as to be located at inside and outside positions, respectively, when the curving portion 16 is curved.

As shown in FIG. 4, the tip side of the manipulation portion 13 and the proximal end side of the insertion tube 17 are fixed to each other with a fixing screw 21. The proximal end side of the insertion tube 17 is formed with a long groove 22. A ring-shaped adjustment ring 23 (see FIG. 3) is interposed between the manipulation portion 13 and a flange portion 24 of the insertion tube 17 so as to be rotatable in the circumferential direction.

A slide cylinder 26 is threadedly engaged with inside female threads 25 of the adjustment ring 23. The slide cylinder 26 is slidably attached to the outer circumferential surface of the insertion tube 17, and is formed with a slide pin hole 27.

A slide member 28 is slidably fitted in the inside surface of the insertion tube 17. A slide pin 29 is fixed to the slide member 28. The slide pin 29 is also fixed to the slide pin hole 27 past the long groove 22. Thus, the slide pin 29 connects the slide cylinder 26 and the slide member 28.

The slide member 28 is formed with a stepped fixing hole 30, in which the first wire members 19 are inserted. The first wire members 19 are fixed to the slide member 28 with a fixing vis 31 in the lateral direction. Thus, the first wire members 19 can be moved (advanced/retreated) in the longitudinal direction by rotating the adjustment ring 23.

On the other hand, the slide member 28 is formed with an insertion hole 32, which allows insertion, with a gap, of internal components such as a light guide fiber bundle (hereinafter referred to as "light guide") 33 for transmitting illumination light from the light source device 6 to the tip portion 14, an image guide fiber bundle (hereinafter referred to as "image guide") 34 for transmitting an image of a body to be ground to the mount portion 12 that is connected to the CCD camera 3, and a flexible, rotational force transmission member 35 for rotating the grindstone 18.

Although not shown any drawings, the mount portion 12 is provided with an imaging optical system for forming an image that is transmitted by the image guide 34 on the imaging surface of the CCD camera 3. Although not shown in any drawings, a motor and a motor control circuit for controlling the rotation of the motor are provided inside the manipulation portion 13. The rotational force transmission member 35 is connected to the rotary shaft of the motor.

As shown in FIG. 5, each of the insertion tube 17 and the tip portion 14 is formed with a plurality of insertion holes 36 that allow insertion of the internal components. That is, through the insertion holes 36, the light guide 33, the image guide 34, and the rotational force transmission member 35 are inserted, with gaps, into the insertion tube 17, the curving portion 16, and the tip portion 14. As shown in FIG. 6, the image guide 34 and the light guide 33 (not shown in FIG. 6) are fixed to the tip of the tip portion 14 and the rotational force transmission member 35 having the grindstone 18 at its tip is fixed to the tip of the tip portion 14 such that the grindstone 18 projects from the tip of the tip portion 14. The first wire members 19 also pass through the insertion holes 36 of the insertion tube 17 and are fixed to the proximal end of the tip portion 14.

The image guide 34 is configured such that a bundle of optical fibers are covered with a Teflon tube 37. Although not shown in any drawings, the light guide 33 is similarly configured such that a bundle of optical fibers are covered with a Teflon tube. The covering with the Teflon tube 37 prevents deterioration of the bundle of optical fibers.

In FIG. 5, the light guide 33, the image guide 34, and the rotational force transmission member 35 are not shown in the curving portion 16 and the tip portion 14.

Returning to FIG. 3, a rotation adjustment knob 41 is provided on the rear end face of the manipulation portion 13. Electrically connected to the motor control circuit (not shown), the rotation adjustment knob 41 serves to control the rotation speed of the motor. A switch 42, which is provided on the front end face of the manipulation portion 13, serves to on/off-control the rotation of the motor via the motor control circuit (not shown).

As described above, the proximal ends of the first wire members 19 are fixed to the slide member 28 which moves in the axial direction as the adjustment ring 23 is rotated in the circumferential direction. As shown in FIG. 7, the tips of the first wire members 19 are fixed to the tip portion 14 by caulking. Thus, the first wire members 19 are mounted so as to be movable with respect to the insertion tube 17.

The second wire members 20 are fixed to the proximal end portion of the tip portion 14 and the tip portion of the insertion portion 11. The second wire members 20 determine the length of a gap 15, i.e., a given interval between the tip portion 14 and the insertion section 11. Thus, the curving portion 16 is constituted of the gap 15, the first wire members 19, and the second wire members 20. That is, the second wire members 20 bridge the tip portion 14 and the insertion portion 11 with a given space formed in between.

The second wire members 20 need not always be fixed; it suffices that the gap 15 of the curving portion 16 be formed in an uncurved state. For example, the second wire members 20 may be inserted in pouch-like holes (blind holes) that are provided in the tip portion 14 and the tip portion of the insertion tube 17 and are so deep in the longitudinal direction that the second wire members 20 do not drop even in a maximum curved state.

Next, the operation of the above-configured first embodiment will be described.

Upon connection of the power supply 8 and the light source device 6 to a socket, electricity is supplied from the power supply 8 to the LCD monitor 7, the industrial endoscope 2, and the CCD camera 3.

In the industrial endoscope 2, illumination light is supplied from the light source device 6 to the light guide 33 having an incident end face in the light source connector 5, transmitted to the tip portion 14 by the light guide 33 which is inserted in the universal cable 4 and the insertion portion 11, and finally emitted forward from the tip portion 14. An image of an inside portion of an engine being illuminated with the illumination light is transmitted by the image guide 34 to the mount portion 12 to which the CCD camera 3 is connected. Thus, the image is picked up by the CCD camera 3. A video signal is sent from the CCD camera 3 to the LCD monitor 7, whereby the image of the inside portion of the engine is checked and observed on the LCD monitor 7.

While the image of the inside portion of the engine is observed on the LCD monitor 7, the insertion portion 11 is inserted and the curving portion 16 is curved by rotating the adjustment ring 23 so that the grindstone 18 is opposed to a part to be ground of a subject body.

Then, the switch 42 is turned on to rotate the motor in the manipulation portion 13, to thereby rotate the grindstone 18 via the rotational force transmission member 35 which is connected to the rotary shaft of the motor. Thus, the part to be ground of the subject body is ground by the grindstone 18. At this time, the rotation speed of the motor can be changed by rotating the rotation adjustment knob 41. If the switch 42 is turned off, the rotation of the motor is stopped and the rotation of the grindstone 18 is also stopped.

The curving operation of the curving portion 16 will be described below with reference to FIGS. 8(*a*) and 8(*b*).

For example, if the adjustment ring 23 is rotated, for instance, clockwise in a state that the curving portion 16 is not curved (see FIG. 8(*a*)), the slide member 28 is pulled up toward the proximal side and the first wire members 19 are also pulled up toward the proximal side following the slide member 28. At this time, since the positions of both ends of the second wire members 20 do not vary, the second wire members 20 are just bent. Thus, as shown in FIG. 8(*b*), a desired curve is obtained in the curving portion 16.

Since the first wire members 19 and the second wire members 20 in the first embodiment are made of a super elastic alloy that is high in both flexibility and straight extendability, the curving portion 16 is curved so as to assume approximately an L shape, i.e., a steep shape close to a right angle, or to assume a bent shape (see FIG. 8(*b*))

By changing the amount of rotation of the adjustment ring 23, the pulling force on the first wire members 19 is changed whereby the curve angle of the curving portion 16 can be adjusted to an arbitrary angle. Because of the use of the metal wire members, sufficient rigidity (sufficient strength for maintaining a curved shape) that is higher than in the case of using a coil, rubber, resin, or the like.

To recover the curving portion 16 now being curved to the original state, the adjustment ring 23 is rotated in the opposite direction. In response, the slide member 28 moves toward the tip and the first wire members 19 also move toward the tip following the slide member 28. As a result, the first wire members 19 that were pulled up toward the proximal side move to toward the tip, to cancel the curve of the curving portion 16. Since the first wire members 19 themselves are high in both flexibility and straight extendability, the insertion tube 17, the curving portion 16, and the tip portion 14 return to a straight state due to restitutive force of the first wire members 19 themselves.

As described above, the first embodiment provides an industrial endoscope that is featured as follows. Even with a simple structure in which the first wire members 19 made of a super elastic alloy are moved by the adjustment ring 23, the curving portion 16 can be curved at a small radius of curvature and a curve angle can be maintained stably. Further, since the curving mechanism consists of only the first wire members 19 and the second wire members 20, the curving portion 16 can secure sufficient space for the internal components.

Although in the first embodiment the curving portion 16 is curved by pulling the first wire members 19, it may be curved in the opposite manner, that is, by pushing the first wire members 19. That is, if the adjustment ring 23 is rotated, for instance, counterclockwise in a state that the curving portion 16 is not curved, the slide member 28 moves toward the tip and the first wire members 19 are pushed toward the tip following the slide member 28. At this time, since the positions of both ends of the second wire members 20 do not vary, the second wire members 20 are just bent. Thus, a desired curve is obtained in the curving portion 16.

The material of the first wire members 19 and the second wire members 20 is not limited to the super elastic alloy. For example, an elastic member made of a material that is high in both flexibility and straight extendability may be used. If a material that is low in flexibility were used, a sufficiently small radius of curvature would not be obtained and a sufficient curve would not be obtained due to high rigidity against curving. If a material that is low in straight extendability, the curving portion 16 would not return to a straight shape when a curve is canceled.

Although in the industrial endoscope 2 the light guide 33, the image guide 34, and the rotational force transmission member 35 are integrated, an endoscope having a soft insertion portion as disclosed in Japanese Patent Application No. Hei. 8-109586 of the present assignee may be inserted in a detachable manner.

Embodiment 2

FIGS. 9–17 relate to a second embodiment of the invention. The parts in the second embodiment that are the same as in the first embodiment are given the same reference numeral and detailed description therefor will be omitted.

As shown in FIG. 9, an insertion portion 11 of an industrial endoscope 2 of the second embodiment consists of an insertion tube 17, a plurality of blocks 61 as tip portion length adjustment member that are arranged at the tip of the insertion tube 17 contiguously in the longitudinal direction, and a tip portion 14.

As shown in FIG. 10, each of the contiguous blocks 61 is formed with insertion holes for insertion of internal components. The internal components, i.e., the light guide 33, the image guide 34, the rotational force transmission member 35, the first wire members 19, and the second wire members 20 are inserted, with gaps, in the insertion holes 62.

As shown in FIG. 11, as in the case of the first embodiment, the image guide 34 is covered with a Teflon tube 37. Although not shown in FIG. 11, the light guide 33 is also covered with a Teflon tube in a similar manner. There are gaps between the insertion holes 62 and the internal components. Since the Teflon tube 37 has good slip performance, the internal component does not make a strong contact with the blocks 61 when the blocks 61 are moved. Therefore, it is possible to move the blocks 61 freely without paying any consideration to the friction with the internal component.

Each block 61 has a recess 63 and a protrusion 64 that constitute a fitting portion 65. The blocks 61 are connected together such that fitting is effected in the respective fitting portions 65. The fitting portions 65 are separably configured. The tip portion 14 is fitted in the tip of the front block 61 detachably and contiguously.

The second wire members **20** secure the interval between the insertion tube **17** and the tip portion **14** so that a gap **15** is formed in between even in a state that all of the plurality of blocks are connected to together. Since the respective blocks **61** are movable in the longitudinal direction, the gap **15** formed between the blocks **61** is also movable. The gap **15** and the exposed first and second wire members **19** and **20** constitute the curving portion **16**. Thus, the curving portion **16** is rendered movable.

As shown in FIG. **12**, adjacent ones of the blocks **61** are connected to each other by fitting the protrusion **64** into the recess **63**. Fitting holes **66** for insertion of the first and second wire members **19** and **20** penetrate through each block **61** in the axial direction. As for the distance between the tip portion **14** and the tip of the insertion tube **17**, the second wire members **20** secure the gap **15** so that it has a constant interval. The gap **15** can be located at an arbitrary position by moving part of the plurality of blocks **61**.

As shown in FIG. 13, in each block **61**, the light guide **33** and the image guide **34** are inserted, with gaps, in the insertion holes **62** that penetrate the block **61** in the axial direction. Similarly, the rotational force transmission member **35** is inserted, with a gap, in the insertion hole **62** that penetrates the block **61** in the axial direction.

The other structures are the same as in the first embodiment.

Next, the operation of the above-configured second embodiment will be described.

As shown in FIGS. **14**(*a*), the gap **15** is formed at a first position by moving part of the blocks **61** in accordance with a known distance between an access port and a blade. Then, the tip portion **14**, the insertion portion **11** is inserted into the access port with the tip portion **14** as the head. As in the case of the first embodiment, while an image is observed, a curving manipulation is performed as shown in FIG. **14**(*b*) so that the grindstone **18** is opposed to a part to be ground of the blade, and then actual processing is performed.

Then, for the next processing, for instance, the gap **15** is formed at a second position by moving part of the blocks **61** in accordance with a known distance between another access port and a blade, as shown in FIG. **15**(*a*). Thereafter, the curving portion **16** is curved by moving the first wire members **19** as shown in FIG. **15**(*b*) and then actual processing is performed.

That is, grinding is performed after a length L between the curving portion **15** to the tip is changed by moving the curving portion **16** (gap **15**) to the tip side as shown in FIGS. **14**(*a*)–**14**(*b*) and **15**(*a*)–**15**(*b*).

The remaining operation is the same as in the first embodiment.

As described above, in the second embodiment, the curving position can be formed at a desired position by changing the positions of part of the movable blocks **61**; the curve position can be set easily only by moving part of the blocks **61**.

Thus, the second embodiment provides the following advantages in addition to the advantages of the first embodiment:

(1) The length of the portion on the tip side of the curving portion **16** can easily be changed without adding any new members for setting the curve position.

(2) The length of the portion on the tip side of the curving portion **16** can easily be changed by a simple operation.

(3) The curving portion **16** can be constructed at a low cost even if the length of the portion on the tip side of the curving portion **16** needs to be variable.

In the second embodiment, the blocks **61** are connected to each other such that the protrusion **64** of each block **61** fits in the recess **63** of the adjacent block **61**. A modification is possible in which among the blocks **61** blocks **61**a on the side of the insertion tube **17** and blocks **61**b on the side of tip portion **14** have different axial lengths h1 and h2 (h1>h2), respectively, and the curving portion **16** is formed from the block **61***b* where the axial length changes from h1 to h2.

In this case, the axial lengths of the recess **63** and the protrusion **64** of the fitting portion of the block **61** vary with the axial length of the block **61**. The fitting gap of the protrusion **64** of the block **61***b* having the axial length h1 is shorter than that of the block **61***a* having the axial length h2, and hence the block **61***b* can be inserted and removed more easily.

The block(s) **61** may be either at least one block or a plurality of blocks that are connected to the proximal end portion of the tip portion **14** or the tip of the insertion tube **17**. Further, the blocks **61** having different axial length may be a plurality of blocks that are arranged regularly or irregularly.

In this modification of the second embodiment, when a curve is formed in the same manner as in the first embodiment, the tip portion **14** receives force that pulls it toward the proximal side.

As shown in FIG. **17**, the force of pulling the tip portion **14** causes the blocks **61** to deviate by slight fitting gaps at the fitting portions. Since a plurality of blocks **61** are connected together, deviations at a plurality of positions are accumulated whereby the portion on the tip side of the curving portion **16** is warped. Although a warp occurs in both of the range where the axial length is h1 and the range where the axial length is h2, the warp in the latter range is larger than the warp in the former range because of the shorter fitting length. The sum of both warp angles amounts to an angle θ that is added to the original curve angle.

Since the warps causes an angle that is larger than the curve angle that is originally given to the curving portion **16**, the access range is increased as much. Further, since the original curve angle can be decreased, the load that is imposed by the curving on each internal component inserted in the curving portion **16** can be reduced.

In a case where the portion on the tip side of the curving portion needs to be short to perform a repair by grinding in the inside of a jet engine, a turbine blade cannot be accessed in a favorable state unless fine length adjustments are possible. The use of the shorter blocks **61***b* on the tip side is convenient in this point because they enable fine length adjustments.

Embodiment 3

FIGS. **18**–**28** relate to a third embodiment of the invention.

As shown in FIG. 18, an endoscope apparatus **101** according to the third embodiment is constituted of the following components. An industrial endoscope **102** has, for instance, a long, flexible insertion portion **121**. A drum device **103** has a drum portion **132** that is rotatable with respect to a stand **131** and on which the insertion portion **121** of the industrial endoscope (hereinafter referred to as "endoscope") **102** is wound. A controller **104** is connected to the proximal end of an elongate electric cable **141** that is detachably connected to the drum device **103**. The controller **104** has a manipulation means and an observation means.

The insertion portion **121** of the endoscope **102** consists of the following components. The proximal end portion of a soft, flexible tube **122** is attached to the drum portion **132**. A curving portion **123** (described later) is provided adjacent to the tip side portion of the flexible tube **122** and is so constructed as to be curved to a desired direction. A tip hard

portion 124 is provided adjacent to the tip-side portion of the curving portion 123 and incorporates a solid-state imaging device as an observation optical system, such as a charge coupled device (hereinafter abbreviated as "CCD"). The tip hard portion 124 is so constructed that plural kinds (two in FIG. 18) of tip adaptors 105*a* and 105*b* for converting the viewing angle or the viewing direction can be detachably mounted thereon. These tip adaptors 105*a* and 105*b* have different lengths, that is, different hard portion lengths.

As shown in FIG. 19, the following components are provided inside the drum portion 132. A camera control unit (hereinafter abbreviated as "CCU") 133 has an image processing circuit for generating a TV signal based on an image that is picked up by the CCD, a timing generation circuit for generating timing signals for driving the CCD, and other circuits. An actuator section 134 constitutes a curving means. A control circuit 136 controls the curving state of the curving portion 123 based on an instruction signal that is sent from the controller 104. A battery 136 serves as a power supply section for the CCD, the actuator section 134, and the control circuit 135. The CCU 133, the actuator section 134, the control circuit 135, and the battery 135 are so constructed as to be given balance weights for optimizing the weight balance of the drum portion 132 in consideration of its balance of rotation.

The tip portion of the electric cable 141 of the controller 104 is provided with a connector 142 that is detachable from a connector connecting portion (described later) provided at the rotation center of the drum portion 132. The controller 104 is also provided with a LCD monitor 143 for displaying an endoscope image that is picked up by the CCD and a joy stick 144 to be manipulated in curving the curving portion 123 to a desired direction.

The endoscope 102 will be described first.

As shown in FIG. 20, for example, the tip adaptor 105*a* having an observation lens cover 151 that constitutes one observation window and illumination lens covers 152 that constitute two illumination windows is connected to the tip face of the tip hard portion 124. A flexible tube front mouth piece 106 is provided between the flexible tube 122 and the curving portion 123. Two metal contacts 106*a* are provided on the outer circumferential surface of the flexible tube front mouth piece 106.

A tip-side structure of the insertion portion 121 will be described below with reference to FIG. 21.

The flexible tube 122 has a three-layer structure including, in order from the outside, an impregnated resin layer 122*a*, a metal mesh layer 122*b*, and a metal spiral tube 122*c*, and is thus rendered flexible.

The generally pipe-shaped flexible tube front mouth piece 106 is provided on the tip side of the flexible tube 122. The metal contacts 106*a* provided on the flexible tube front mouth piece 106 are a cathode metal contact 106*n* and an anode metal contact 106*p*. The metal contacts 106*n* and 106*p* are connected to the ends of electric cables 106*b* corresponding to the characteristics of the metal contacts 106*n* and 106*p*, respectively. The metal contacts 106*n* and 106*p* are provided on the flexible tube front mouth piece 106 through non-conductive collars 106*c*. A non-conductive coil spring 106*d* is provided on the outer circumferential surface of the flexible tube front mouth piece 106 so as to protect the metal contacts 106*n* and 106*p*.

One end portion of a resin cover made of synthetic rubber that is an elastic member constituting the curving portion 123 covers the tip portion of the flexible tube front mouth piece 106, and the other end portion of the resin cover 125 covers the proximal end portion of the tip hard portion 124. The resin cover 125 is fixed to the flexible tube front mouth piece 106 and the tip hard portion 124 in an integral manner by means of a thread-wound bonding portions (not shown) that are provided on both end portions of the resin cover 125. Thus, the resin cover 125 bridges the flexible tube front mouth piece 106 and the tip hard portion 124 with a given space provided in between. Instead of the resin cover 125, a tubular elastic member made of a material that is high in both flexibility and straight extendability, such as a super elastic alloy (Ni—Ti alloy), may be used.

One end portions of manipulation wires 126 as wire members that constitute, together with the resin cover 125, the curving portion 123 are connected to the tip hard portion 124. The manipulation wires 126 are wire members made of a Ni—Ti type alloy that exhibits a super elastic characteristic and is generally called a super elastic alloy. The manipulation wires 126 extend through the flexible tube front mouth piece 106 and the flexible tube 122, and the other end portions of the manipulation wires 126 are connected and fixed to the actuator section 134 as the curving means for moving the manipulation wire 126 in the longitudinal direction of the insertion portion 121. The actuator section 134 is provided in the drum portion 132. In the third embodiment, three manipulation wires 126 are used, an arrangement of which will be described later with reference to FIG. 23.

To detect a curving direction, each of the manipulation wires 126 is provided, in the curving portion 123, with a sensor 126*a* such as a strain gauge. Curving state detection signals produced by the respective sensors 126*a* are transmitted by signal transmission lines 126*b* extending from the respective sensors 126*a* and input to the control circuit 135 in the drum portion 132.

The tip hard portion 124 is provided with a CCD 127 that constitutes an observation optical system and contact electrodes 128 as second electrical contacts to serve as cathode and anode contacts for supplying illumination power to, for instance, an LED device (hereinafter referred to as "LED") as a light-emitting element that constitutes an illumination optical system (described later).

The CCD 127 has a driver circuit 127*a* for driving it, a preamplifier 127*b* for amplifying an electrical signal produced through photoelectric conversion of an image formed on the imaging surface of the CCD 127, and other circuits. A signal cable 129 for signal exchange extends from the driver circuit 127*a* and the preamplifier 127*b* to the drum portion 132, going through the flexible tube front mouth piece 106 and the flexible tube 122. The proximal end of the signal cable 129 is connected to the CCU 133 that is provided in the drum portion 132.

On the other hand, one ends of electric wires 128*a* corresponding to the characteristics of the above-mentioned contact electrodes 128 are connected to those electrodes, respectively. The electric wires 128*a* goes through the insertion portions 121 and the other ends of electric wires 128*a* are connected to the battery 136 which is provided in the drum portion 132.

The tip portion of the tip hard portion 124 is provided with the tip adaptor 105*a* having an observation lens cover 151 and an objective lens 153 that constitute the observation optical system and an LED 154 that emits illumination light. The tip adaptor 105*a* is connected and fixed to the tip of the insertion portion 121 through a rotary ring 150 whose inner circumferential surface is formed with a female thread portion that engages a male thread portion (not shown) formed on the outer circumferential surface of the tip hard portion 124. The rotary ring 150 is provided with a watertight member (not shown) for preventing dust, water, or the

like from entering the inside of the endoscope **102** through the connecting portion of the tip adaptor **105***a* and the tip hard portion **124**.

The LED **154** which is provided in the tip adaptor **105***a* has a cathode terminal **154***n* and an anode terminal **154***p* that are opposed to the contact electrodes **128** provided in the tip hard portion **124**. The optical axis of the LED **154** coincides with the viewing direction of the observation optical system.

The tip adaptor **105***a* is provided with a conduction holder **107** that is made of an insulative material. The conduction holder **107** is formed with fitting through-holes **173** which are fitted with conductive, coil-shaped compression springs **171** and metal balls **172** for electrical conduction between the contact electrodes **128** and the cathode and anode terminals **154***n* and **154***p* of the LED **154**. As shown in FIG. **22**(*a*), when the fitting through-holes **173** are fitted with the metal balls **172** and the compression springs **171**, the cathode and anode terminals **154***n* and **154***p* contact the end faces of the respective compression springs **171**. Thus, first electrical contacts are formed. In a state that the tip adaptor **105***a* is not attached to the tip hard portion **124**, urging force of the compression strings **171** causes the balls **172** (provided on theproximalside) to project from the proximal face by a dimension a.

On the other hand, as shown in FIG. **22**(*b*), in a state that the tip adaptor **105***a* is attached to the tip hard portion **124**, the metal balls **172** being urged by the compression springs **171** are brought in contact with the tip faces of the respective contact electrodes **128**. As a result, the LED **154** is turned on being supplied with illumination power from the battery **136** via the electric wires **128***a*, the contact electrodes **128**, the metal balls **172**, the compression springs **171**, and the cathode and anode terminals **154***n* and **154***p*. Since the urging force of the compression springs **171** causes the metal balls **172** to be always pressed against the tip faces of the respective contact electrodes **128**, reliable conduction can be obtained irrespective of the manipulation on the endoscope **102**.

As shown in FIG. **23**, the three manipulation wires **126** which are part of the curving portion **123** are provided in equilateral triangle form and fixed to the tip hard portion **124** at positions close to its outer circumferential surface to secure sufficient internal space, so as not to butt against the contact electrodes **128** for supplying power to the LED **154**.

The three manipulation wires **126**, which are fixed to the tip hard portion **124** and extend to the drum portion **132**, are arranged such that at least one of a plurality of planes each formed by an arbitrary pair of the three manipulation wires **126** does not include the central axis of the insertion portion **121**(curving portion).

Therefore, when at least one of the three manipulation wires **126** is moved by the actuator section **134**, the remaining manipulation wire(s) **126** that is not moved by the actuator section **134** resists the moving manipulation wire **126** and is curved toward the moving manipulation wire **126**.

Next, the drum device **103** will be described.

As shown in FIG. **24**, the proximal end portion of the flexible tube **122** which is part of the insertion portion **121** is connected to a connection member **132***b* that is provided on a winding surface **132***a* of the drum portion **132**. Each of the manipulation wires **126** goes through the curving portion **123**, the flexible tube front mouth piece **106**, and the flexible tube **122**, and reaches the inside of the drum portion **132**. One end portion of each manipulation wire **126** is connected to a rack **134***b* a rack-pinion portion **134***a* that constitutes the actuator **134**. The rack **134***b* advances or retreats in accordance with the rotation of a pinion **134***c*, which is rotated by a motor **137**. The motor **137** is fixed to the inside of the drum portion **132**.

As shown in FIG. **25**, three rack-pinion portions **134***a* are provided in the actuator section **134** so as to correspond to the three respective manipulation wires **126** which are inserted in the insertion portion **121**. The end portion of each manipulation wire **126** is connected to the rack **134***b* of each rack-pinion portion **134***a*.

The manipulation wires **126** advance or retreat independently of each other in accordance with the operations of the respective rack-pinion portions **134***a*. By causing the respective rack-pinion portions **134***a* to advance or retreat by properly controlling their operations, the manipulation wires **126** that are fixed to the respective racks **134***b* advance or retract accordingly, whereby the curving portion **123** is curved to a desired direction.

An alternative configuration is possible in which the curving portion **123** is curved by pushing at least one of the manipulation wires **126** from the initial position where a curve is canceled to the curving portion side, and the curve thus produced is canceled by returning the manipulation wire **126** to the initial position.

As shown in FIG. **24**, the end portions of the signal transmission lines **126***b* and the signal cable **129** that go through the insertion portion **121** and reach the inside of the drum portion **132** are connected to the control circuit **135** and the CCU **133**, respectively, which are provided in the drum portion **132**.

As for a specific manner of attaching the insertion portion **121** of the endoscope **102** to the drum portion **132**, reference is made to FIG. **26**. That is, as shown in FIG. **26**, the connection member **132***b* to which the proximal end portion of the flexible tube **122** (insertion portion **121**) is connected can be detachably fixed to the winding surface **132***a* of the drum portion **132** with vises.

The connection member **132***b* is provided with a connector **132***c* that is electrically connected to the CCU **133** and the control circuit **135** (and the battery **136**) which are provided in the drum portion **132**. By connecting the connector **132***c* of the connection member **132***b* to a corresponding connector in the drum portion **132**, the signal transmission lines **126***b* and the signal cable **129** which are inserted in the insertion portion **121** are connected to the control circuit **135** and the CCU **133**. The connection between the insertion portion **121** and the drum portion **132** is completed by fixing the connection member **132***b* to the winding surface **132***a* with vises after the connector **132***c* is connected to the corresponding connector.

To obtain a rotation speed that is reduced from the rotation speed of the motor **137**, a reduction gear mechanism may be provided between a rotary shaft **137***a* of the motor **137** and the pinion **134***c*.

Next, a description will be made of a connection relationship between the controller **104** and the control circuit **135** and the CCU **133**.

As shown in FIG. **24**, a connector receptacle **131***a* incorporating a bearing portion **131***b* projects from a side face of the stand **131** of the drum device **103**. A shaft portion **138**, which projects from aside face central portion of the drum portion **132** and has a plurality of contact portions on the bottom face of a connector connecting portion **139**, is attached to the bearing portion **131***b* of the connector receptacle **131***a* so as to be rotatable with respect to the stand **131**.

The bottom face of the connector connecting portion **139** of the shaft portion **138** which projects from the drum portion **132** is provided with a video signal contact electrode **139**a to which a video signal line **133***a* extending from the CCU **133** is connected and a ground (or GND) terminal **139***b*

to which a ground line **133***b* is connected, as well as with communication photodiodes **139***c* and communication LEDs **139***d* that are connected to communication cables **135***f* for bidirectional communication extending from the control circuit **135**.

The video signal contact electrode **139***a* to which the video signal line **133***a* is connected is provided in a non-conductive first holder **175** that is located on the rotation central axis of the drum portion **132**. On the other hand, the GND terminal **139***b* to which the ground line **133***b* is connected is accommodated in a non-conductive second holder **176** that is located at a position distant from the video signal contact electrode **139***a* and close to the outer circumferential surface of the connector connecting portion **139**. The GND terminal **139***b* is always urged sideways and outward by a compression spring **171** that is provided in the second holder **176**. Diffusion plates **139***e* are disposed in front of the communication photodiodes **139***c* and the communication LEDs **139***d*.

On the other hand, the tip face of a connector **142** that is inserted in the connector receptacle **131***a* and connected to the connector connecting portion **139** is provided with a video signal connection terminal **142***a*, a GND contact electrode **142***b*, communication LEDs **142***c*, and communication photodiodes **142***d* so as to be opposed respectively to the video signal contact electrode **139***a*, the GND terminal **139***b*, the diffusion plates **139***c* that are disposed in front of the communication photodiodes **139***c* and the communication LEDs **139***d*.

The video signal connection terminal **142***a* is accommodated in a non-conductive third holder **176***a* that is sealed and fixed with a filler or the like at the center of the connector **142**. The video signal connection terminal **142***a* is always urged sideways and outward by a compression spring **171***a* that is provided in the third holder **176***a*. The communication LEDs **142***c* and communication photodiodes **142***d* are sealed and fixed with a filler or the like so as to be opposed respectively to the communication photodiodes **139***c* and the communication LEDs **139***d* which are provided in the connector connecting portion **139**. Further, the GND contact electrode **142***b* is formed in ring-like form on the tip face of the connector **142** so as to provide reliable conduction with the GND terminal **139***b* which is located close to the outer circumferential surface of the connector connecting portion **139**.

With the above configuration, light that is emitted from the communication LEDS **142***c* based on a curving instruction signal that is produced as a result of a manipulation on the joy stick **144** provided on the controller **104** is diffused by the diffusion plates **139***e* of the connector connecting portion **139**, reaches the photodiodes **139***c*, and finally transmitted to the control circuit **135** via the communication cable **135***f*. Even if the connector **142** is attached to the connector connecting portion **139** in any circumferential positional relationship with the latter, emitted light is transmitted, as a curving instruction signal, to the control circuit **135** in a reliable manner by virtue of the use of a plurality of communication LEDs **142***c* and the diffusion effect of the diffusion plates **139***e*.

Since the video signal connection terminal **142***a* to contact the video signal contact electrode **139***a* which is connected to the video signal line **133***a* extending from the CCU **133** and the GND terminal **139***b* to contact the GND contact electrode **142***b* provided in the connector **142** are always pressed by the urging force of the compression springs **171***a* and **171** to as to contact the contact electrodes **139***a* and **142***b*, respectively, signal exchange can be performed in such a state that reliable conduction is established between the terminals **139***b* and **142***a* and the contact electrodes **139***a* and **142***b*.

An O-ring **131***c* is provided on the inner circumferential surface of the connector receptacle **131***a* on its mouth side to prevent entrance of dust, water, or the like into the inside of the connecting portion as well as falling of the connector **142** from the connector receptacle **131***a*.

The operation of the above-configured endoscope apparatus **101** will be described with reference to a block diagram of FIG. **27**.

The tip hard portion **124** of the endoscope **102** is provided with the LED **154** for illuminating a part to be observed, the CCD **127** for imaging the part to be observed that is illuminated by the LED **154**, the driver circuit **127***a* for driving the CCD **127**, and the preamplifier **127***b* for amplifying an electrical signal that is produced through photoelectric conversion of an image formed on the imaging surface of the CCD **127**. The sensors **126***a* for detecting curving states of the respective manipulation wires **126** are provided at intermediate positions, in the curving portion **123**, of the manipulation wires **126** whose tips are fixed to the tip hard portion **124** and which extend to the actuator section **134**.

The drum portion **132** of the drum device **103** incorporates the CCU **133** having the image processing circuit for producing a video signal from an electrical signal supplied from the CCD **127** and other circuits, the actuator section **134** for advancing or retreating the manipulation wires **126**, the control circuit **135** for controlling, for instance, a curving state of the curving portion **123**, and the battery **136** as a power supply.

The LED **154** is turned on being supplied with power from the battery **136** when the flexible tube **122** constituting the insertion portion **121** is connected and fixed to the drum portion **132**.

The controller **104** is provided with the joy stick **144** as a manipulation switch, A CPU **145** for converting a movement of the joy stick **144** into a curving instruction signal, a communication circuit **146** for supplying the thus-produced curving instruction signal to the control circuit **135**, a TV signal receiving circuit **147** as a receiving section of a TV signal that is transmitted from the CCU **133**, the LCD monitor **143** as a TV monitor, and a superimposer **148** for causing the LCD monitor **143** to display image information and text information.

The CCD driver circuit **127***a* which is provided in the tip hard portion **124** is driven by drive signals that are output from a timing generation circuit **161** that is provided in the CCU **133**.

An electrical signal obtained by amplification, by the preamplifier **127***b*, of a signal that is produced based on an image formed on the imaging surface of the CCD **127** is transmitted to an image processing circuit of the CCU **133**. In the image processing circuit, the received electrical signal is subjected to known processing in the clamping circuit **162** and a sample hold circuit **163**, amplified by a amplifier (not shown), and then A/D-converted by an A/D conversion circuit **164**. Image data produced by the A/D conversion is input to a memory **165**. Based on the image data, a DSP (digital signal processor) **167** produces a video signal of a given format according to a program stored in a DSP ROM **166**. After passing through a first frame memory **168***a* or a second frame memory **168***b*, the video signal is D/A-converted by a D/A conversion circuit **169** and then input to an encoder **170**, which produces a TV signal to be output to the external apparatus. The TV signal is output to the TV

signal receiving circuit **147** of the controller **104** via a TV signal transmission circuit **170a**.

In summary, an image that is picked up by the CCD **127** is converted into an electrical signal, which is amplified by the preamplifier **127b** and then transmitted to the CCU **133**. Based on the received electrical signal, the CCU **133** produces a TV signal, which is output to the TV signal receiving circuit **147** of the controller **104** via the TV signal transmission circuit **170a**. The TV signal is then displayed on the LCD monitor **143** via the superimposer **148**.

When a curving manipulation on the curving portion **123** is made by manipulating the joy stick **144** of the controller **104**, a curving instruction signal representing a movement of the joy stick **144** is supplied from the joy stick **144** to a control CPU **135b** via the CPU **145**, the communication circuit **146**, and a communication circuit **135a** of the control circuit **135** which is provided in the drum portion **132**.

Upon reception of the curving instruction signal, the control CPU **135b** controls, via a curving control circuit **135c**, a curving driver circuit **135d** so that the curving driver circuit **135d** supplies a drive signal to a related motor **137** of the actuator section **134**, to start driving the motor **137**. As a result, the pinion **134c** is rotated by a specified amount in a specified direction, the rack **134b** is moved accordingly, and finally the corresponding manipulation wire **126** is moved in the specified direction.

As a result, the remaining, i.e., unmoved, manipulation wire(s) **126** resists the moving manipulation wire **126**, to establish a state that the tip hard portion **124** is pulled toward the flexible tube front mouth piece **106**. Thus, the manipulation wires **126** are warped and the curving portion **123** is curved to one of the directions indicated by arrows in FIG. **28**.

When the curving portion **123** starts to curve as shown in FIG. **28**, stress amounts are detected by the sensors **126a** which are provided on the respective manipulation wires **126**, and curving state detection signals representing the respective stress amounts are transmitted to a sensor signal receiving circuit **135e** of the control circuit **135**. The received curving state detection signals are supplied to the control CPU **135b** via the curving control circuit **135c**. After the curving state detection signals are compared with the curving instruction signal that is supplied from the joy stick **144**, the curving driver circuit **135d** again outputs a drive signal to the actuator section **134**, which advances or retreats the respective manipulation wires **126** so that the curving portion **123** is curved in the direction according to the instruction from the joy stick **144**.

As described above, where the distal end portion of the three manipulation wires **126** each made of a super elastic alloy are fixed to the tip hard portion **124** which is located at the tip of the insertion portion **121**, the three manipulation wires **126** are arranged so that at least one of planes each of which is formed by arbitrarily selected two of the three manipulation wires **126** does not include the central axis of the tip hard portion **124** and the curving portion **123** which constitute the insertion portion **121**, and the curving mechanism is constructed by connecting the proximal ends of the respective manipulation wires **126** to the rack-pinion portions **134a** which advance or retreat the respective manipulation wires **126**. Thus, by properly adjusting the movements of the respective manipulation wires **126** for the respective rack-pinion portions **134a**, the curving portion **123** can be curved to a desired direction.

The sensors **126a** for detecting curving states of the three respective manipulation wires **126** are provided thereon at the intermediate positions, in the curving portion **123**, of the respective manipulation wires **126**, and curving state detection signals that are output from the respective sensors **126a** are supplied to the curving control circuit **135c** of the control circuit **135**. The curving state detection signals are compared with a curving instruction signal that is supplied from the joy stick **144**. Based on comparison results, a drive signal for controlling the curving state of the curving portion **123** is newly output to the actuator section **134** from the curving driver circuit **135d**, to advance ot retreat the respective manipulation wires **126**. Thus, the curving portion **123** can be curved in a reliable manner to the direction according to the instruction from the joy stick **144**.

Further, by virtue of the fact that the curving portion **123** and the curving mechanism are formed by using the three manipulation wires **126**, wider space can be secured in the curving section **123** than in the conventional curving portion that is constituted of a plurality of curving blocks and a manipulation wire for curving a curving tube that is formed by the plurality of curving blocks. Since sufficient space for insertion of the internal components other than the curving mechanism is secured, it is no longer necessary to reduce the diameters of the respective internal components and, on the other hand, it becomes possible to reduce the diameter of the endoscope insertion portion.

The LED **154** is provided in the tip adaptor (**105a**), and illumination light is emitted from the LED **154** that is supplied with power from the battery **136** of the drum portion **132** when the flexible tube that constitutes the proximal portion of the insertion portion **121** is connected to the drum portion **132**. In this manner, a part to be inspected can always be illuminated with a necessary amount of light. This eliminates problems of optical loss due to long extension of light guide fibers that are usually used as an illumination means and reduction or insufficiency in light quantity due to optical loss at the connection face with a tip adaptor. Further, it is no longer necessary to increase the fiber diameter or use expensive fibers having high transmission efficiency to efficiently transmit illumination light from a very distant light source device to a part to be observed. This realizes thinning of the endoscope and an inexpensive configuration.

By virtue of the fact that the video signal contact electrode **139a** to which the video signal line **133a** extending from the CCU **133** is connected and the video signal connection terminal **142a** which is provided in the connector **142** are located on the rotation central axis of the drum portion **132**, a failure in conduction between the video signal contact electrode **139a** and the video signal connection terminal **142a** due to the rotation of the drum portion **132** can be prevented in a reliable manner.

Further, the metal balls **172** which are provided in the tip adaptor (**105a**) are always pressed against the tip faces of the contact electrodes **128** by the urging force of the compression springs **171**, and the video signal connection terminal **142a** and the ground terminal **139b** are always pressed against the video signal contact electrode **139a** and the ground contact electrode **142b** by the urging force of the compression springs **171a** and **171**, respectively. Therefore, reliable conduction can be established between the metal balls **172** and the contact electrodes **128**, between the video signal connection terminal **142a** and the video signal contact electrode **139a**, and between the ground terminal **139b** and the ground contact electrode **142b**.

Although in the third embodiment the LED **154** is used as the illumination means, a similar configuration may be obtained by replacing the LED **154** with a lamp. Further, like the first embodiment, a grinding means comprising the

grinding stone **18**, the rotational force transmission member **35**, and the like may be provided in the insertion portion **121**.

Embodiment 4

FIGS. **29–32** relate to a fourth embodiment of the invention.

The configuration of an endoscope **102** will be described first.

As shown in FIG. **29**, in the fourth embodiment, four manipulation wires **126** are used, that is, the number of manipulation wires **126** is increased by one from the case of the third embodiment. The four manipulation wires **126** are fixed to the tip hard portion **124** at four equally divided positions close to its outer circumferential surface so as to serve as up, down, right, and left manipulation wires **126U**, **126D**, **126R**, and **126L**.

One end of an interval maintaining wire **181** as a wire rod for keeping the interval of the curving portion **123** at a given value is fixed to the tip hard portion **124** at a position approximately on the central axis. The other end of the interval maintaining wire **181** is fixed to the flexible tube front mouth piece **106** at a position approximately on the central axis.

Further, the resin cover **125** which covers the curving portion **123** in the third embodiment is replaced by a composite tube of a metal mesh tube **122*b*** and a metal spiral tube **122*c*** that are provided concentrically. In the composite tube, either the metal mesh tube **122*b*** or the metal spiral tube **122*c*** may be provided outside.

Next, the structure of an actuator section **134** will be described.

As shown in FIG. **30**, the actuator section **134** of the fourth embodiment is constituted of a link mechanism portion having a top/bottom link bar **182** to which the up and down manipulation wires **126U** and **126D** are connected and a right/left bar **183** to which the right and left manipulation wires **126R** and **126L** are connected, screw-type linear driving members **184** that are respectively connected to the up/down link bar **182** and the right/left link bar **183**, motors **185** for driving the respective screw-type linear driving members **184**. In FIG. **30**, the screw-type linear driving member **184** connected to the right/left link bar **183** and the motor **185** for driving it are omitted.

The link bar **182** which constitutes a up/down link mechanism portion is axially supported so as to be rotatable about a shaft **186** that is fixed to the inside of the drum portion **132**. One end of the link bar **182** is connected to one end of the screw-type linear driving member **184** which is advanced or retreated by the motor **185**. With this structure, for example, by rotating the motor **185** by a drive signal that is supplied from the curving driver circuit **135*d***, the link bar **182** which is connected to the screw-type linear driving member **184** from a position indicated by solid lines to a position indicated by broken lines. As a result, as shown in FIG. **31**, the up manipulation wire **126U** is pulled while the down manipulation wire **126D** is pushed; that is, a pair of manipulation wires **126U** and **126D** are simultaneously subjected to a push/pull manipulation. As a result, the curving portion **123** is curved to the direction of the up manipulation wire **126U** that is being pulled.

The structure relating to the right-left direction is not described because it is the same as the above-described structure relating to the up-down direction. The up and down manipulation wires **126U** and **126D** are fixed to the link bar **182** at positions that are equally distant from the shaft **186** as the supporting point. Similarly, the right and left manipulation wires **126R** and **126L** are fixed to the link bar **183** at positions equally distant from the shaft **186**. Since the other

structures of the third embodiment are the same as those of the third embodiment, descriptions therefor are omitted with the same parts and components given the same reference symbols.

Next, the operation of the above-configured endoscope apparatus will be described.

As in the case of the third embodiment, a curving instruction signal is supplied to the control CPU **135*b*** by manipulating the joy stick **144**. In response, the control CPU **135*b*** controls, via the curving control circuit **135*c***, the curving driver circuit **135*d*** so that the curving control circuit **135*d*** supplies drive signals to the motors **185** corresponding to the up/down and right/left directions, respectively, whereby the motors **185** start rotating. As a result, the screw-type linear driving members **184** advance or retreat in specified directions, and the link bars **182** and **183** which are connected to the respective screw-type linear driving members **184** turn about the respective shafts **186**. As a result, the up and down manipulation wires **126U** and **126D** which are connected to the link bar **182** and/or the right and left manipulation wires **126R** and **126L** move relatively to each other, whereby the position of the tip hard portion **124** with respect to the flexible tube front mouth piece **106** is changed. In this manner, the interval maintaining wire **181** is warped and the curving portion **123** can be curved freely in a desired direction as shown in FIG. **32**.

As described above, the number of manipulation wires is increased and the interval maintaining wire **181** as the member for keeping the interval of the curving portion **123** at a given value is fixed to the tip hard portion **124** and the flexible tube front mouth piece **106**. As the manipulation wires **126** are moved, the interval maintaining wire **181** is warped and the curving portion **123** is curved. In this manner, the curving control can be performed with high accuracy.

Further, since the interval of the curving portion **123** is kept at a given value by means of the interval maintaining wire **181**, the curving portion **123** can be curved at a small radius of curvature and a curve angle can be maintained in a stable manner.

Although in the fourth embodiment the number of manipulation wires is increased, the curving portion **123** may be formed by using the interval maintaining wire **181** and two manipulation wires **126**. Even in this case, it is possible to curve the curving portion **123** to a desired direction by properly setting the arrangement positions of the interval maintaining wire **181** and the manipulation wires **126**. A plurality of interval maintaining wires **181** may be provided. Further, instead of increasing the number of link mechanisms as the number of manipulation wires **126** is increased, the number of rack-pinion portions may be increased as the number of manipulation wires **126** is increased. Further, instead of a compound tube comprising the metal mesh layer **122*b*** and the metal spiral tube **122*c***, as shown in the second embodiment, the tip portion length adjustment member which comprises the plurality of blocks **61**, **61*a*** and **61*b*** may be provided.

Embodiment 5

FIGS. **33** and **34** relate to a fifth embodiment of the invention.

The fifth embodiment is directed to an industrial endoscope apparatus in which the grindstone **18** of the first embodiment for grinding a subject body is replaced by an eddy current examination probe for non-destructive inspection. The same parts and components as in the first embodiment are given the same reference symbols and descriptions therefor will be omitted.

As shown in FIG. 33, an insertion portion 11 of an industrial endoscope 2 of the fifth embodiment includes, in order from the tip, a tip portion 14, a curving portion 16 having a plurality of wire members and a predetermined gap 15, and a hard, an elongate insertion tube 17. A manipulation portion 13 is provided with a processing member manipulation portion side opening 201 for insertion of, for instance, a laser probe for repairing a blade by welding, an eddy current examination probe for detecting a fault in a blade, or a gripping tool for collecting fallen things in an engine. A processing tool insertion passage 202 extends from the processing member manipulation portion side opening 201 past the insertion tube 17 to a processing member tip portion side opening 203.

An eddy current examination probe 204 is inserted from the processing member manipulation portion side opening 201 and projected from the processing member tip portion side opening 203. The proximal end portion of the eddy current examination probe 204 is connected to an external eddy current measuring device 206 via a connector 205.

An eddy current pickup coil 207 such as a circular coil for generation of eddy current is incorporated in the tip portion of the eddy current examination probe 204. An eddy current signal line 208 that is connected to the eddy current pickup coil 207 extends to the connector 205. With this configuration, a detection signal produced by the eddy current pickup coil 207 is sent to the external eddy current measuring device 206 via the eddy current signal line 208. The eddy current examination probe 204 has a Teflon sheath as a cover.

The other structures are the same as in the first embodiment or the second embodiment. Further, like the third embodiment, it may be structured that the manipulation wire is driven by the motor to perform the curving control.

Next, the operation of the above-configured fifth embodiment will be described.

The insertion portion 11 is inserted from an access port to a desired blade as a subject body. While an endoscope image is observed on the LCD monitor 7, the curving portion 16 is curved by rotating the adjustment ring 23 and the insertion portion 11 is pushed or pulled so that the eddy current examination probe 204 is rendered approximately perpendicular to the blade. The tip of the eddy current examination probe 204 is moved across the wall surface of the blade (scanning is performed). When current is caused to flow through the eddy current pickup coil 205, eddy current occurs on the blade wall surface. As the eddy current pickup coil 205 is moved, the leakage magnetic field above the blade wall surface varies if a crack extends in a direction that traverses an eddy current flowing path. The crack can be detected by picking up a variation in leakage magnetic field by the eddy current pickup coil 205. The eddy current measuring device 206 causes the monitor 7 to display a waveform. Since the waveform on the monitor 7 reflects an abnormality such as a crack, a crack or the like can be detected.

The eddy current pickup coil 205 is not limited to a circular coil, and may be a rectangular coil, a bobbin coil, or a ring-shaped coil.

The invention is not limited to the above embodiments and various modifications can be made without departing from the spirit and scope of the invention.

What is claimed is:

1. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion and formed to have a plurality of insertion passages;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval;

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion; and

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire.

2. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval;

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion;

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire; and

observing means extending from the tip portion past the space portion to the proximal side of the insertion portion.

3. The endoscope according to claim 2, further comprising a processing member insertion passage extending from the tip portion past the space portion to the insertion portion, and disposed in the insertion portion.

4. The endoscope according to claim 3, wherein the elastic member is a plurality of wire members that are disposed at positions deviated from the central axis of the space portion.

5. The endoscope according to claim 3, wherein the manipulation wire is a plurality of manipulation wires that are disposed at positions deviated from the central axis of the space portion.

6. The endoscope according to claim 3, wherein the curving mechanism comprises moving means for moving the manipulation wire from a reference position to a distal side, and returning means for returning, to the reference position, the manipulation wire that has moved to the distal side.

7. The endoscope according to claim 3, wherein the curving mechanism comprises an actuator for controlling movement of the manipulation wire so that the manipulation wire can advance and retreat.

8. The endoscope according to claim 2, further comprising:

a rotational force transmission member extending from the tip portion past the space portion to the proximal side of the insertion portion; and

a rotary grinding member provided on a distal side of the rotational force transmission member,

wherein the rotational force transmission member transmits rotational force of a motor to the rotary grinding member.

9. The endoscope according to claim 8, wherein the elastic member is a wire rod made of a super elastic alloy.

10. The endoscope according to claim 8, wherein the manipulation wire is a wire rod made of a super elastic alloy.

11. The endoscope according to claim 8, wherein the elastic member is a plurality of wire members that are disposed at positions deviated from the central axis of the space portion.

12. The endoscope according to claim 8, wherein the manipulation wire is a plurality of manipulation wires that are disposed at positions deviated from the central axis of the space portion.

13. The endoscope according to claim 8, further comprising a tip portion length adjustment member that can be connected to at least one of the proximal end portion of the tip portion and the distal end portion of the insertion portion.

14. The endoscope according to claim 13, wherein the tip portion length adjustment member comprises a plurality of blocks that can be connected to each other.

15. The endoscope according to claim 14, wherein the plurality of blocks include blocks having the same axial length.

16. The endoscope according to claim 14, wherein the plurality of blocks include blocks having different axial lengths.

17. The endoscope according to claim 16, wherein among the plurality of blocks, blocks disposed on a proximal side have a longer axial length than blocks disposed on a distal side.

18. The endoscope according to claim 8, wherein an internal component in the tip portion and the insertion portion is disposed at a position that is closer to the central axis than positions of the elastic member and the manipulation wire.

19. The endoscope according to claim 8, wherein the curving mechanism comprises moving means for moving the manipulation member from a reference position to a distal side, and returning means for returning, to the reference position, the manipulation wire that has moved to the distal side.

20. The endoscope according to claim 8, wherein the curving mechanism comprises an actuator for controlling movement of the manipulation wire so that the manipulation wire can advance and retreat.

21. The endoscope according to claim 20, further comprising:

- a sensor provided on the manipulation wire, for detecting a curving state; and
- a control section for controlling the actuator based on an output of the sensor.

22. The endoscope according to claim 2, further comprising:

- a processing member insertion passage extending from the tip portion past the space portion to the insertion portion, and disposed in the insertion portion; and
- an eddy current examination probe inserted in the processing member insertion passage.

23. The endoscope according to claim 22, wherein the elastic member is a wire rod made of a super elastic alloy.

24. The endoscope according to claim 22, wherein the manipulation wire is a wire rod made of a super elastic alloy.

25. The endoscope according to claim 22, wherein the elastic member is a plurality of wire members that are disposed at positions deviated from the central axis of the space portion.

26. The endoscope according to claim 22, wherein the manipulation wire is a plurality of manipulation wires that are disposed at positions deviated from the central axis of the space portion.

27. The endoscope according to claim 22, further comprising a tip portion length adjustment member that can be connected to at least one of the proximal end portion of the tip portion and the distal end portion of the insertion portion.

28. The endoscope according to claim 27, wherein the tip portion length adjustment member comprises a plurality of blocks that can be connected to each other.

29. The endoscope according to claim 28, wherein the plurality of blocks include blocks having the same axial length.

30. The endoscope according to claim 28, wherein the plurality of blocks include blocks having different axial lengths.

31. The endoscope according to claim 30, wherein among the plurality of blocks, blocks disposed on a proximal side have a longer axial length than blocks disposed on a distal side.

32. The endoscope according to claim 22, wherein an internal component in the tip portion and the insertion portion is disposed at a position that is closer to the central axis than positions of the elastic member and the manipulation wire.

33. The endoscope according to claim 22, wherein the curving mechanism comprises moving means for moving the manipulation member from a reference position to a distal side, and returning means for returning, to the reference position, the manipulation wire that has moved to the distal side.

34. The endoscope according to claim 22, wherein the curving mechanism comprises an actuator or controlling movement of the manipulation wire so that the manipulation wire can advance and retreat.

35. The endoscope according to claim 34, further comprising:

- a sensor provided on the manipulation wire, for detecting a curving state; and
- a control section for controlling the actuator based on an output of the sensor.

36. The endoscope according to claim 2, wherein the tip portion is so constructed that any of a plurality of optical adaptors having different hard portion lengths can be detachably mounted thereon.

37. The endoscope according to claim 36, further comprising:

- an optional adaptor;
- a light-emitting element provided on the optical adaptor; and
- an electrical contact provided between the optical adaptor and the tip portion, for supplying power to the light-emitting element.

38. The endoscope according to claim 37, therein the light-emitting element is an LED.

39. The endoscope according to claim 38, wherein the elastic member is a wire rod made of a super elastic alloy.

40. The endoscope according to claim 38, wherein the manipulation wire is a wire rod made of a super elastic alloy.

41. The endoscope according to claim 38, wherein the elastic member is a plurality of wire members that are disposed at positions deviated from the central axis of the space portion.

42. The endoscope according to claim 38, wherein the manipulation wire is a plurality of manipulation wires that are disposed at positions deviated from the central axis of the space portion.

43. The endoscope according to claim 38, further comprising a tip portion length adjustment member that can be

connected to at least one of the proximal end portion of the tip portion and the distal end portion of the insertion portion.

44. The endoscope according to claim 43, wherein the tip portion length adjustment member comprises a plurality of blocks that can be connected to each other.

45. The endoscope according to claim 44, wherein the plurality of blocks include blocks having the same axial length.

46. The endoscope according to claim 44, wherein the plurality of blocks include blocks having different axial lengths.

47. The endoscope according to claim 46, wherein among the plurality of blocks, blocks disposed on a proximal side have a longer axial length than blocks disposed on a distal side.

48. The endoscope according to claim 38, wherein an internal component in the tip portion and the insertion portion is disposed at a position that is closer to the central axis than positions of the elastic member and the manipulation wire.

49. The endoscope according to claim 38, wherein the curving mechanism comprises moving means for moving the manipulation member from a reference position to a distal side, and returning means for returning, to the reference position, the manipulation wire that has moved to the distal side.

50. The endoscope according to claim 38, wherein the curving mechanism comprises an actuator for controlling movement of the manipulation wire so that the manipulation wire can advance and retreat.

51. The endoscope according to claim 50, further comprising:

a sensor provided on the manipulation wire, for detecting a curving state; and

a control section for controlling the actuator based on an output of the sensor.

52. The endoscope according to claim 2, wherein the elastic member is a wire rod made of a super elastic alloy.

53. The endoscope according to claim 2, wherein the manipulation wire is a wire rod made of a super elastic alloy.

54. The endoscope according to claim 2, wherein the elastic member is a plurality of wire members that are disposed at positions deviated from the central axis of the space portion.

55. The endoscope according to claim 2, wherein the manipulation wire is a plurality of manipulation wires that are disposed at positions deviated from the central axis of the space portion.

56. The endoscope according to claim 2, further comprising a tip portion length adjustment member that can be connected to at least one of the proximal end portion of the tip portion and the distal end portion of the insertion portion.

57. The endoscope according to claim 56, wherein the tip portion length adjustment member comprises a plurality of blocks that can be connected to each other.

58. The endoscope according to claim 57, wherein the plurality of blocks include blocks having the same axial length.

59. The endoscope according to claim 57, wherein the plurality of blocks include blocks having different axial lengths.

60. The endoscope according to claim 59, wherein among the plurality of blocks, blocks disposed on a proximal side have a longer axial length than blocks disposed on a distal side.

61. The endoscope according to claim 2, wherein an internal component in the tip portion and the insertion portion is disposed at a position that is closer to the central axis than positions of the elastic member and the manipulation wire.

62. The endoscope according to claim 2, wherein the curving mechanism comprises moving means for moving the manipulation wire from a reference position to a distal side, and returning means for returning, to the reference position, the manipulation wire that has moved to the distal side.

63. The endoscope according to claim 2, wherein the curving mechanism comprises an actuator for controlling movement of the manipulation wire so that the manipulation wire can advance and retreat.

64. The endoscope according to claim 18, further comprising:

a sensor provided on the manipulation wire, for detecting a curving state; and

a control section for controlling the actuator based on an output of the sensor.

65. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion haying a given interval;

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion;

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire; and

a processing member insertion passage extending from the tip portion past the space portion to the insertion portion, and disposed in the insertion portion,

wherein the elastic member is a wire rod made of a super elastic alloy.

66. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval:

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion;

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire; and

a processing member insertion passage extending from the tip portion past the space portion to the insertion portion, and disposed in the insertion portion,

wherein the manipulation wire is a wire rod made of a super elastic alloy.

67. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval;

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion;

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire;

a processing member insertion passage extending from the tip portion past the space portion to the insertion portion, and disposed in the insertion portion; and

a tip portion length adjustment member that can be connected to at least one of the proximal end portion of the tip portion end the distal end portion of the insertion portion.

68. The endoscope according to claim **67**, wherein the tip portion length adjustment member comprises a plurality of blocks that can be connected to each other.

69. The endoscope according to claim **68**, wherein the plurality of blocks include blocks having the same axial length.

70. The endoscope according to claim **68**, wherein the plurality of blocks include blocks having different axial lengths.

71. The endoscope according to claim **70**, wherein among the plurality of blocks, blocks disposed on a proximal side have a longer axial length than blocks disposed on a distal side.

72. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval;

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion;

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire; and

a processing member insertion passage extending from the tip portion past the space portion to the insertion portion, and disposed in the insertion portion,

wherein an internal component in the tip portion and the insertion portion is disposed at a position that is closer to the central axis than positions of the elastic member and the manipulation wire.

73. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval;

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion;

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of the tip portion at the space portion by advancing or retreating the manipulation wire;

a processing member insertion passage extending from the tip portion past the space portion to the insertion portion, and disposed in the insertion portion;

a sensor provided on the manipulation wire, for detecting a curving state; and

a control section for controlling the actuator based on an output of the sensor

wherein the curving mechanism comprises an actuator for controlling movement of the manipulation wire so that the manipulation wire can advance and retreat.

74. An endoscope apparatus comprising:

a tip hard portion having an observation optical system and an illumination optical system;

a cylindrical, elastically deformable curving portion provided on a proximal side of the tip hard portion;

an elongate insertion portion provided adjacent to the curving portion on a proximal side thereof;

at least three wire members having distal end portions fixed to the hard portion and proximal end portions inserted at least to the curving portion;

curving means provided on a proximal side of the insertion portion, for curving the curving portion; and

one or a plurality of tip length varying blocks provided between the tip hard portion and the insertion portion, each of the one or plurality of tip length varying blocks having a fitting hole in which the at least three wire members are fitted and a fitting portion for allowing adjacent ones of the tip length varying blocks to fit into each other,

wherein when at least one of the at least three wire members is advanced or retreated in a longitudinal direction of the insertion portion by the curving means, remaining one or ones of the at least three wire members that are not advanced or retreated by the curving means resist movement of the at least one wire member that is advancing or retreating, whereby all of the at least three wire members are curved to the same direction as the at least one advancing or retreating wire member is curved.

75. An endoscope comprising:

an elongate insertion portion;

a tip portion disposed on a distal side of the insertion portion;

an elastic member bridging a distal end portion of the insertion portion and a proximal end portion of the tip portion so as to form therebetween a space portion having a given interval;

a manipulation wire disposed at a position deviated from a central axis of the space portion, and extending to a proximal side of the insertion portion past the space portion, one end of the manipulation wire being fixed to the tip portion;

a curving mechanism connected to a proximal end portion of the manipulation wire, for changing a direction of

the tip portion at the space portion by advancing or retreating the manipulation wire; and

a tip portion length adjustment member that can be connected to at least one of the proximal end portion of the tip portion end the distal end portion of the insertion portion.

76. The endoscope according to claim **75**, wherein the tip portion length adjustment member comprises a plurality of blocks that can be connected to each other.

77. The endoscope according to claim **76**, wherein the plurality of blocks include blocks having the same axial length.

78. The endoscope according to claim **76**, wherein the plurality of blocks include blocks having different axial lengths.

79. The endoscope according to claim **78**, wherein among the plurality of blocks, blocks disposed on a proximal side have a longer axial length than blocks disposed on a distal side.

80. The endoscope according to claim **75**, wherein an internal component in the tip portion and the insertion portion is disposed at a position that is closer to the central axis than positions of the elastic member and the manipulation wire.

81. The endoscope according to claim **75**, wherein the curving mechanism comprises moving means for moving the manipulation wire from a reference position to a distal side, and returning means for returning, to the reference position, the manipulation wire that has moved to the distal side.

82. The endoscope according to claim **75**, wherein the curving mechanism comprises an actuator for controlling movement of the manipulation wire so that the manipulation wire can advance and retreat.

83. The endoscope according to claim **75**, wherein the elastic member is a wire rod made of a super elastic alloy.

84. The endoscope according to claim **75**, wherein the manipulation wire is a wire rod made of a super elastic alloy.

85. The endoscope according to claim **75**, wherein the elastic member is a plurality of wire members that are disposed at positions deviated from the central axis of the space portion.

86. The endoscope according to claim **75**, wherein the manipulation wire is a plurality of manipulation wires that are disposed at positions deviated from the central axis of the space portion.

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